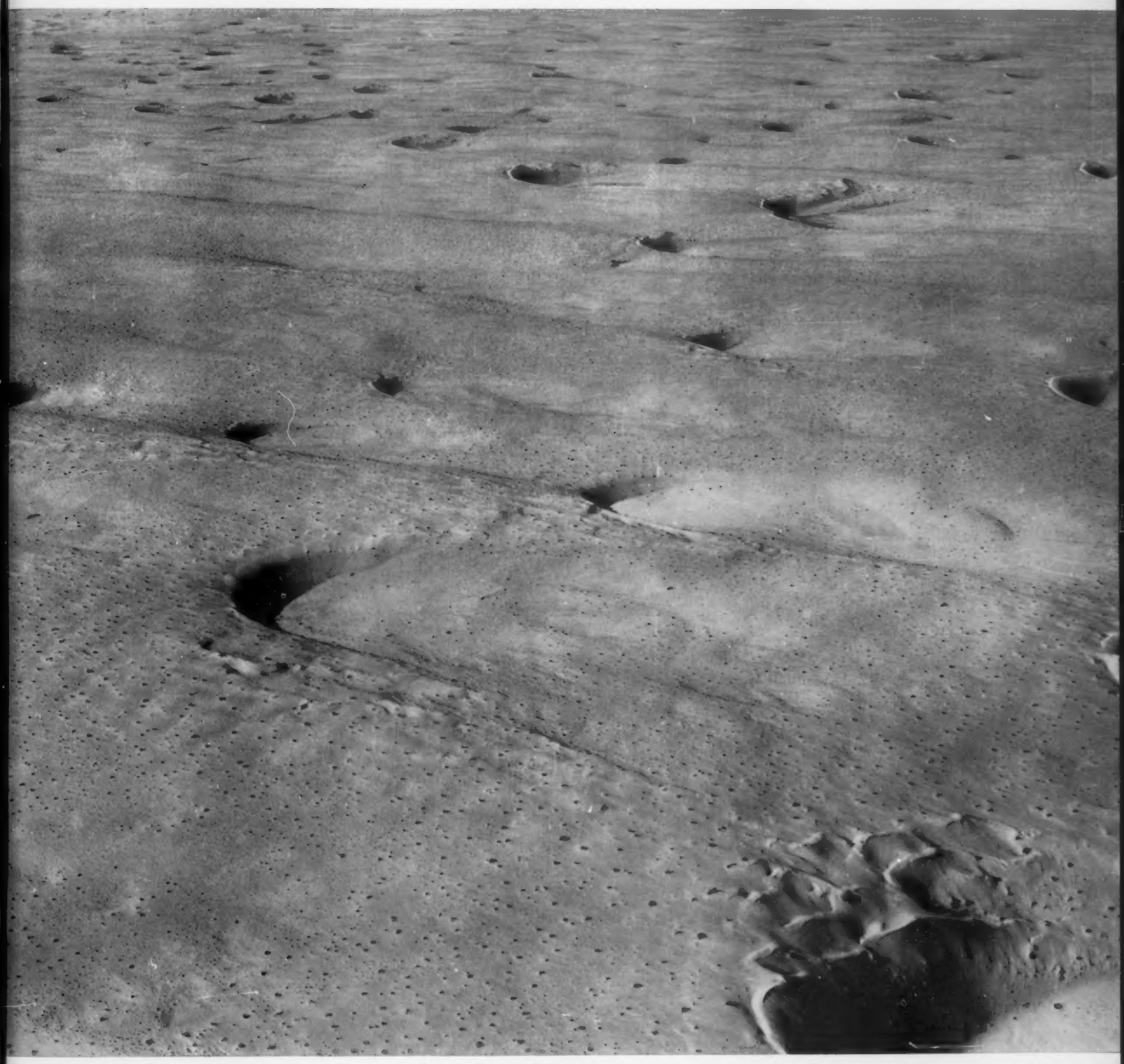
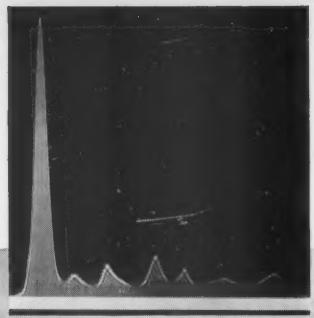
SCIENCE

11 November 1960

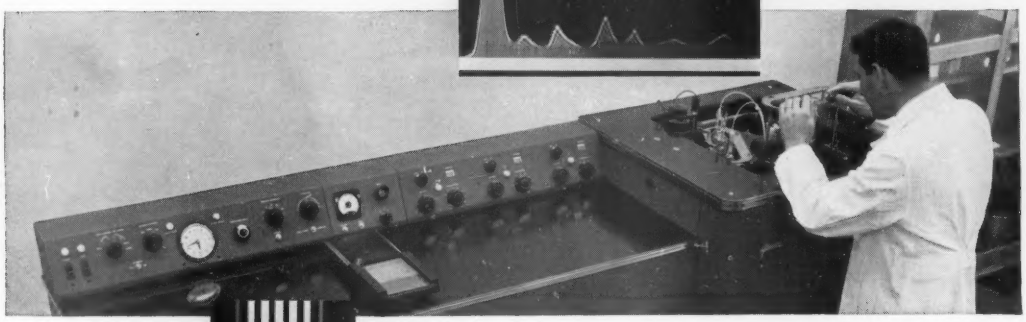
Vol. 132, No. 3437

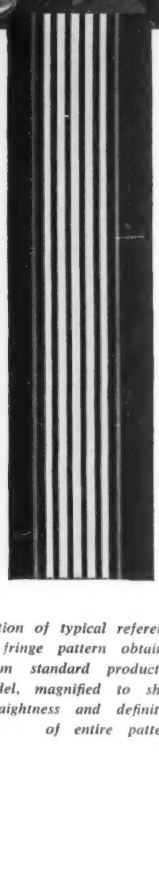
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE





Electrophoresis of human plasma diluted 1:6; ascending boundaries. Inclined knife-edge schlieren.





Portion of typical reference fringe pattern obtained from standard production model, magnified to show straightness and definition of entire pattern.

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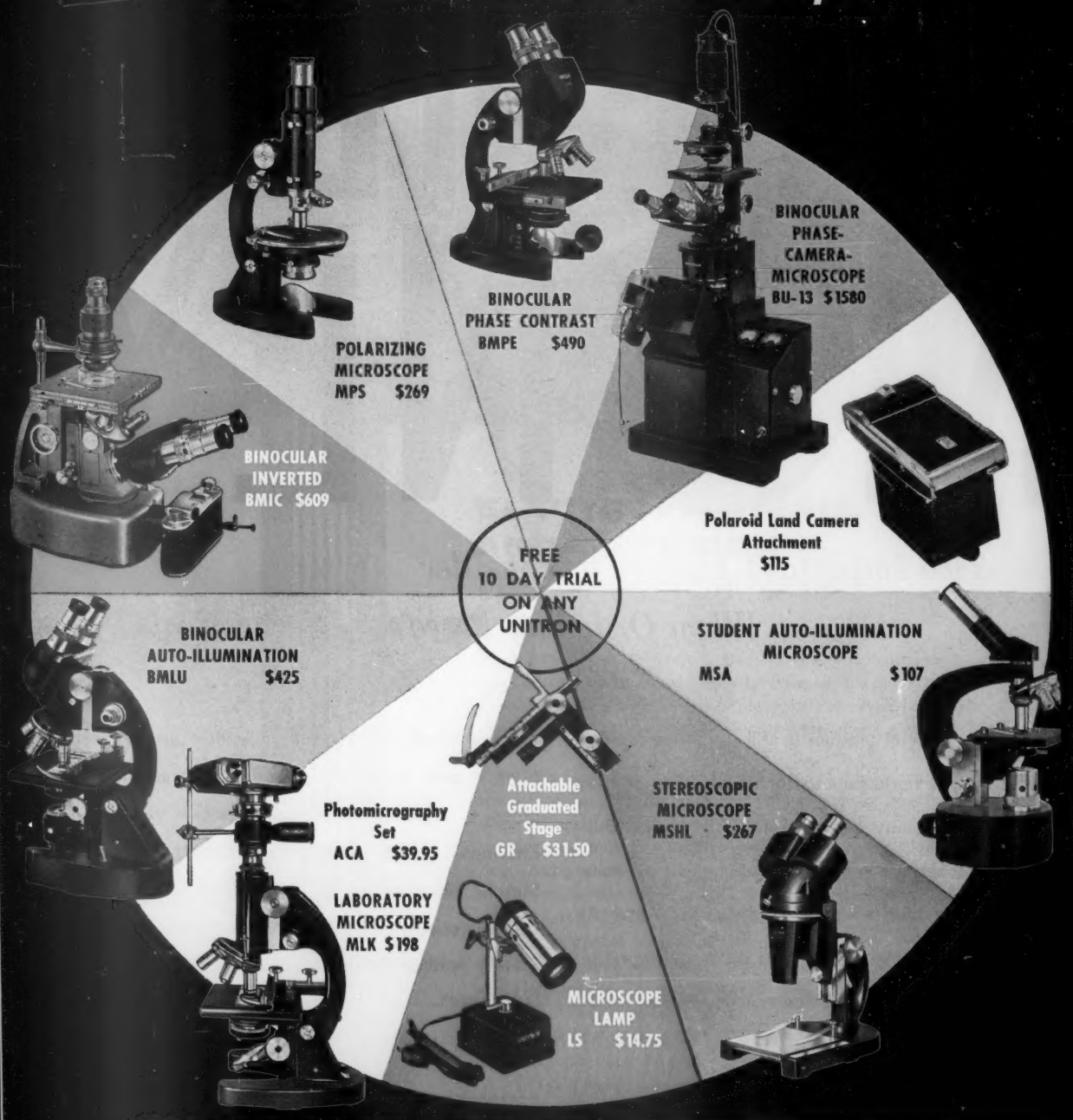

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SCIENCE

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Giant crescentive hollows and slipfaces in the Great Nafud, looking northwest. See page 1369. [Arabian American Oil Co.]

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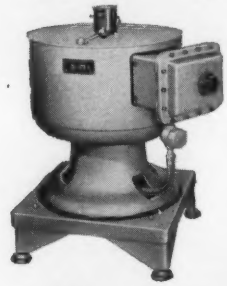

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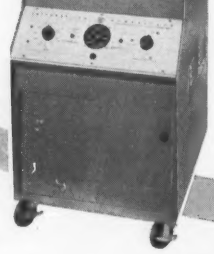

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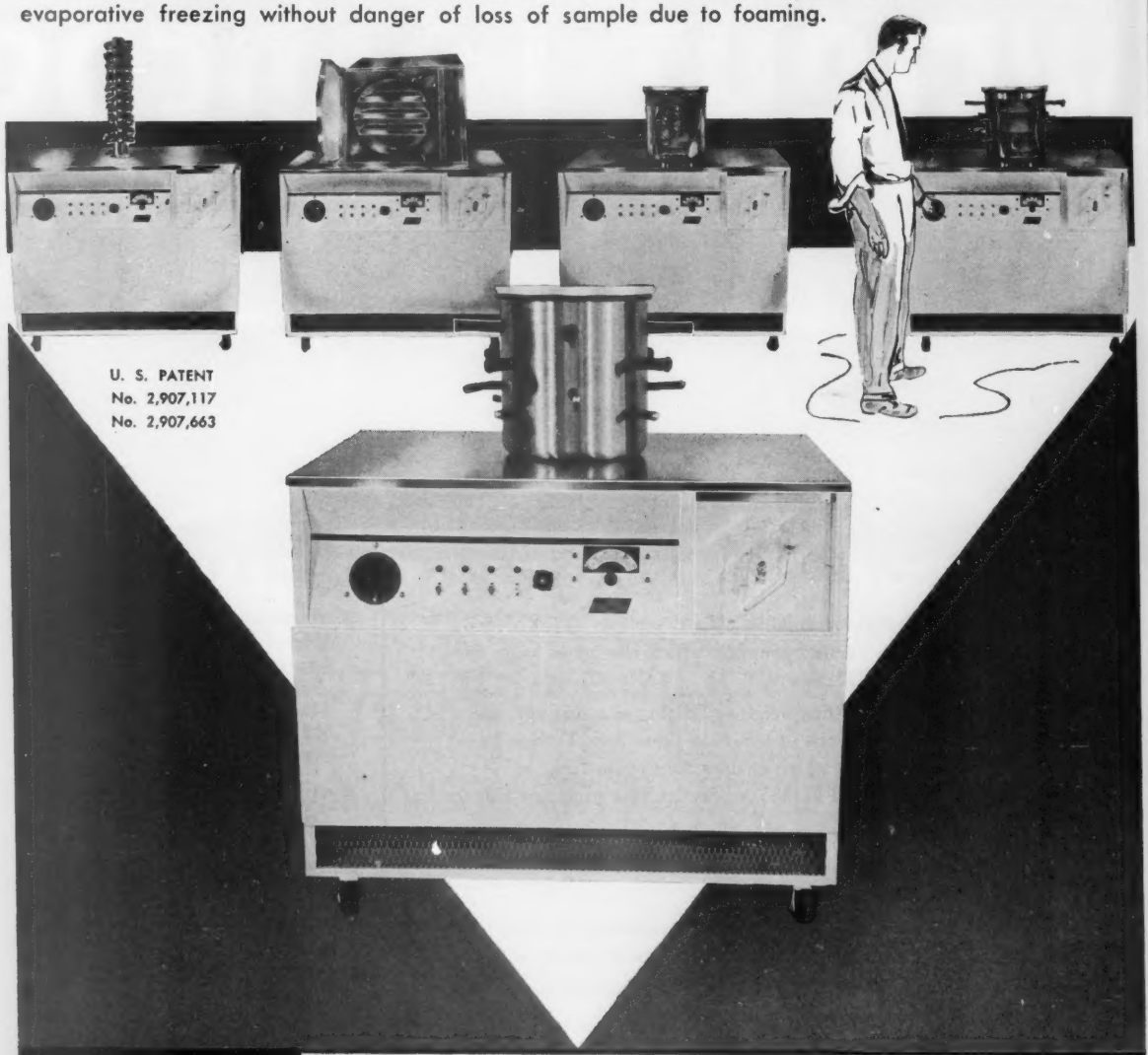

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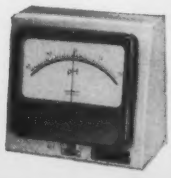

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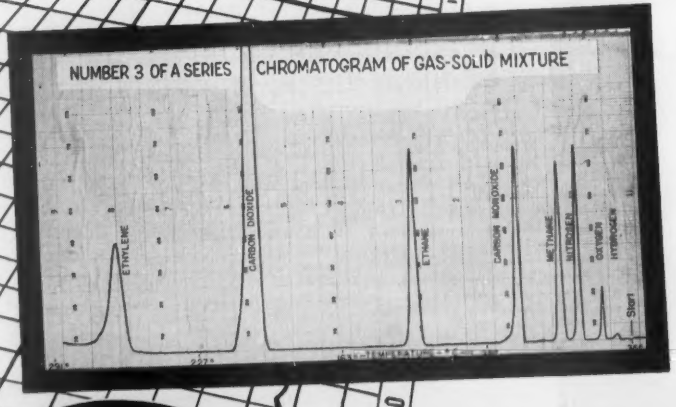

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(8.) Mikelson, L., private communications.

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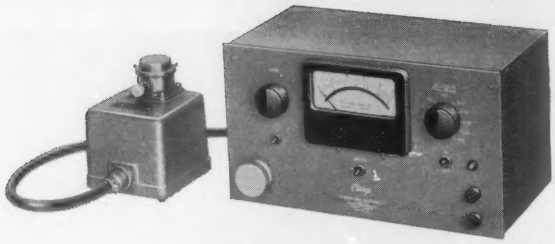

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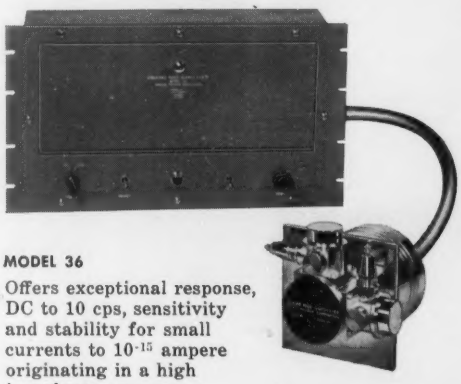

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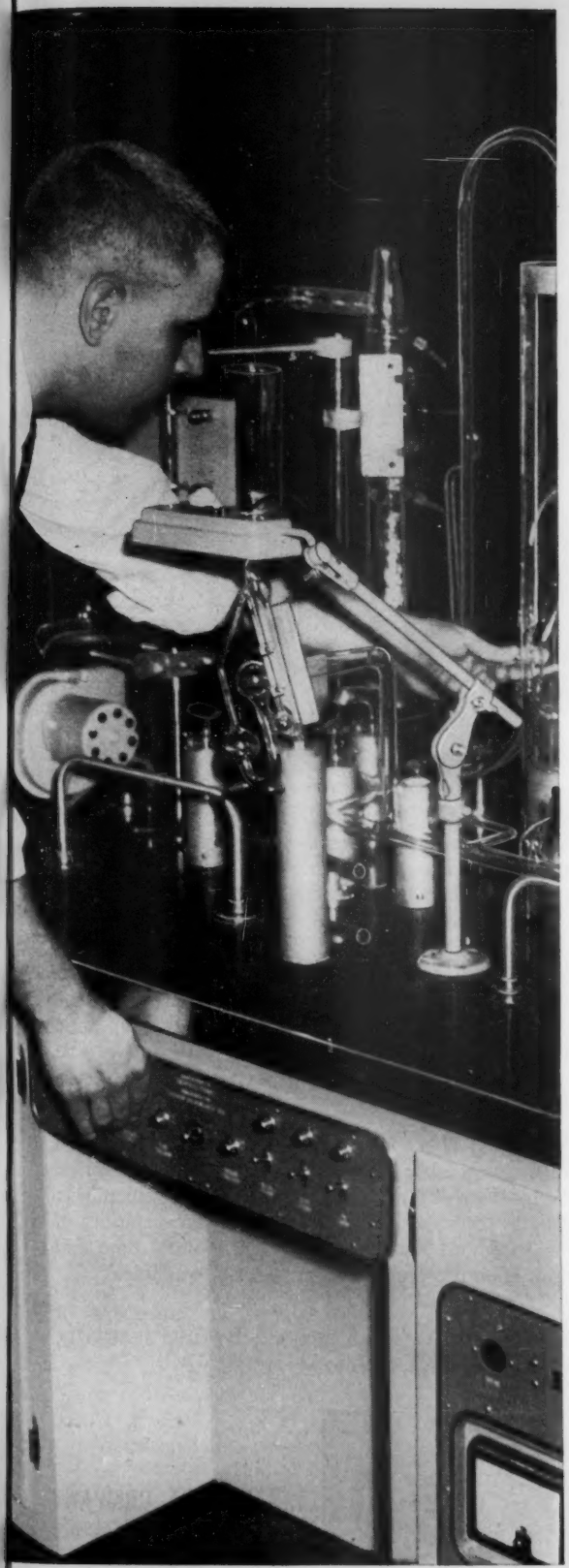

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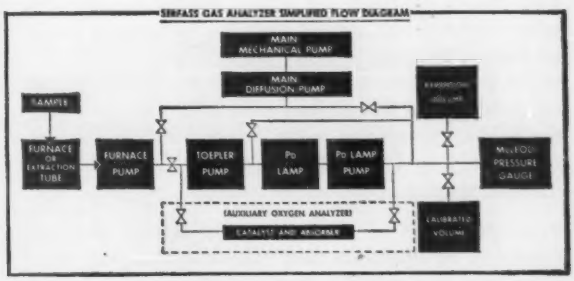

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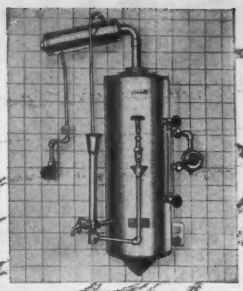

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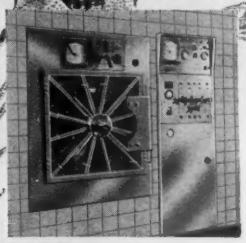

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Pressure Steam, Gas-Steam, and Gas. Chambers 16″ x 16″ x 24″ to 60″ x 66″ x 120″.

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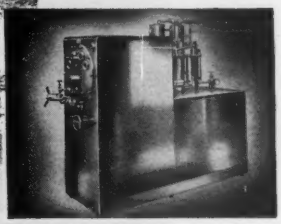

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For batch or continuous culture of pure microorganisms in controlled conditions.

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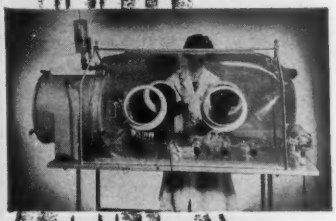

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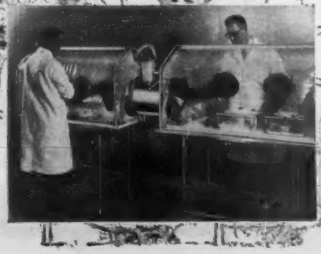

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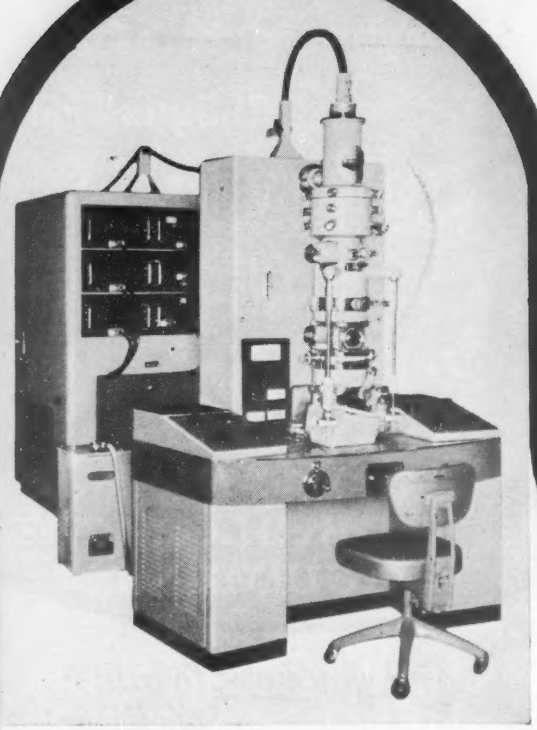
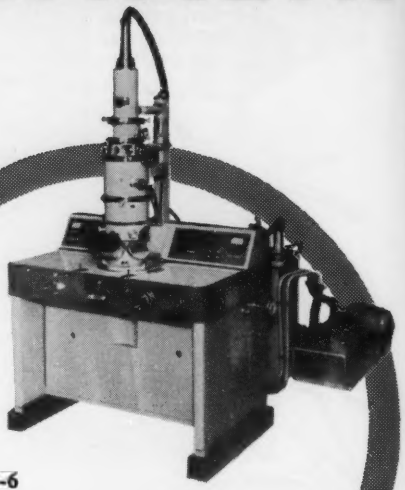


HU-11



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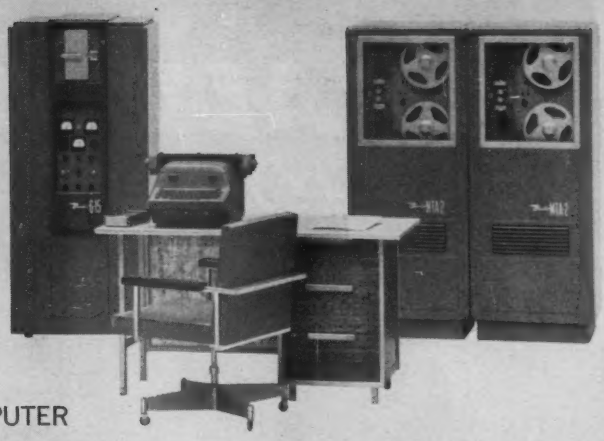

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* AN ALGEBRAIC COMPILER BASED ON INTERNATIONAL ALGOL.

PROBLEM: $$I = \frac{E}{\sqrt{R^2 + (6.2832\,FL - 1/6.2832\,FC)^2}}$$

(For values of R F & L as specified. For values of E ranging from 100 to 300 in increments of 50. For values of C ranging from .00002 to .000021 in increments of .0000001)

COMPLETE ALGO PROGRAM:

```
BEGIN ⓢ
R = 10 ⓢ
F = 60 ⓢ
L = ₀2 ⓢ
FOR E = 100(50)300 BEGIN ⓢ
FOR C = ₀00002(₀0000001)₀000021 BEGIN ⓢ
I = E/SQRT(R ↑ 2 + (6₀2832 * F * L — (1/(6₀2832 * F * C))) ↑ 2) ⓢ
PRINT (FL) = E ⓢ
PRINT (FL) = C ⓢ
PRINT (FL) = I ⓢ
```

Write on your letterhead for the self-teaching ALGO manual.

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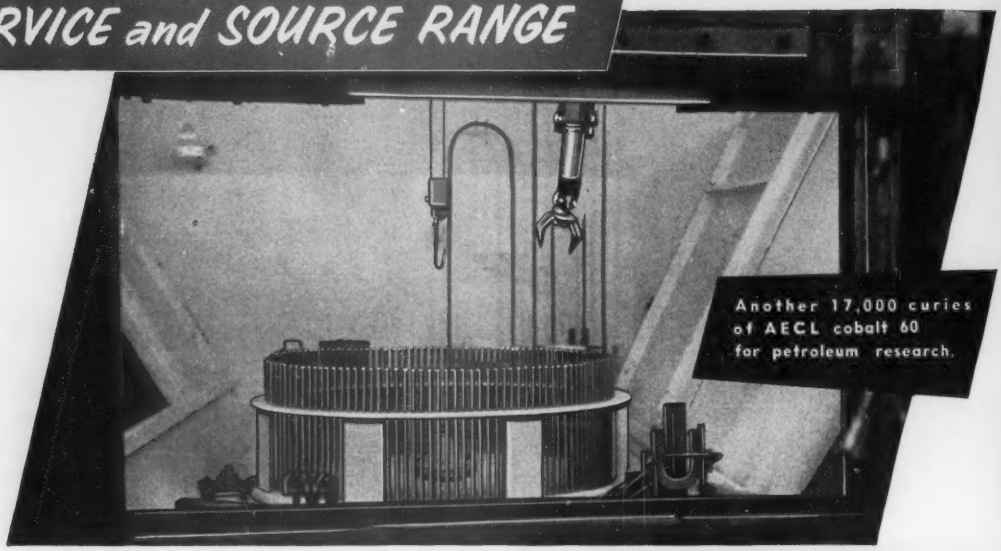

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The fantastic accuracies needed by inertial guidance systems for space flight depend on the suppression of gyro drift, the tendency of a gyro to precess from minutely occurring internal torques. Particularly puzzling has been the problem of "jogs," or sudden axial shifts, within gyro spin-axis bearings. Shifts of but one ten-millionth of an inch can cause serious steering error.

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Conducting unique studies of single bearings apart from rotor assemblies, GM Researchers use a hydrostatic spindle and special instrumentation to take film-thickness measurements they compare with hydrodynamic theory. Jogs, due to excess oil supply, have been analyzed in relation to surface oil transfer and separator feed control, ball spin orientation, displacement, and differential heating and ball wander.

This experimental and analytical approach is achieving progress toward jog-free, stably distributed, and suitably thick oil films required in high-precision bearings. It is a further example of the critical and advanced research General Motors carries out in seeking "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan

The fluoresced streaks show the disturbed "wake" of the lubricating film during bearing operation. The active part of the film, too thin to fluoresce visibly, averages ten-millionths of an inch in thickness.

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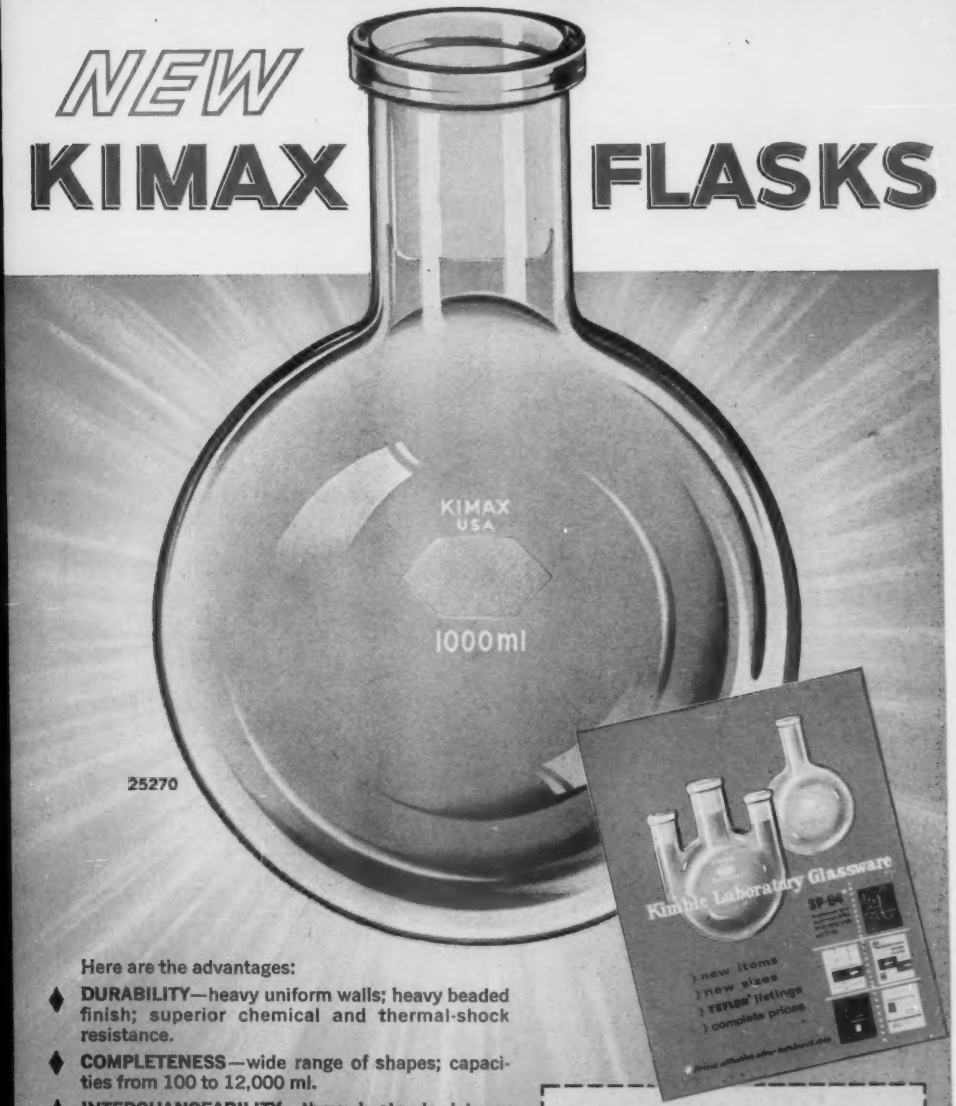

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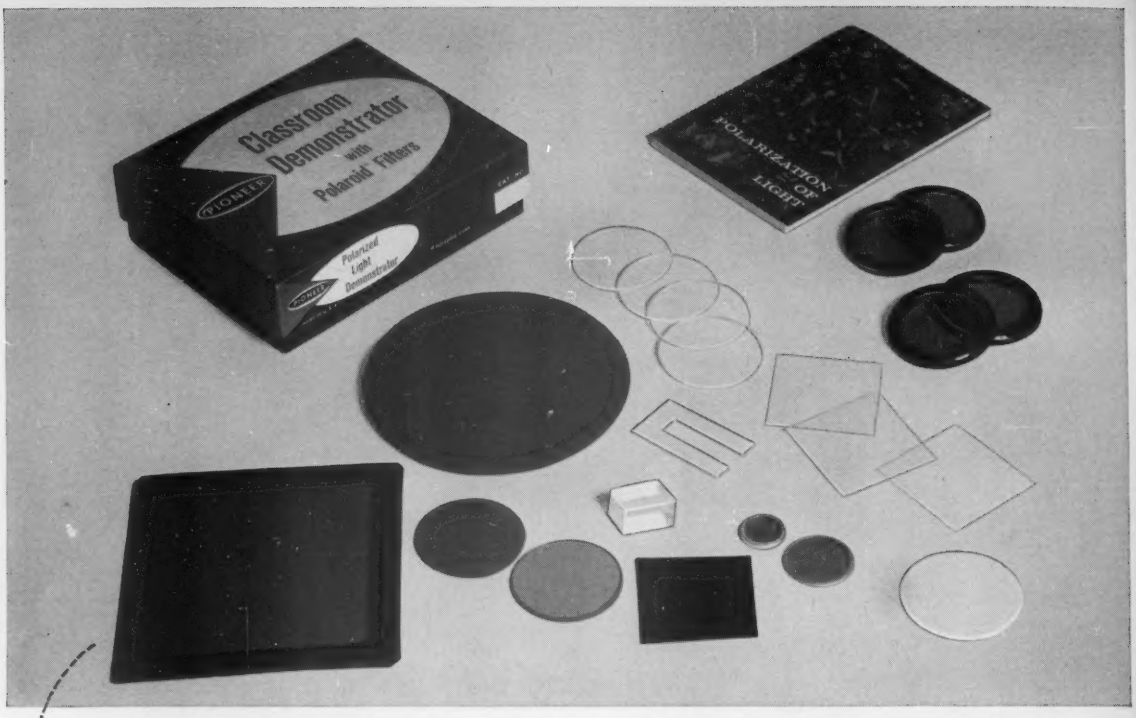

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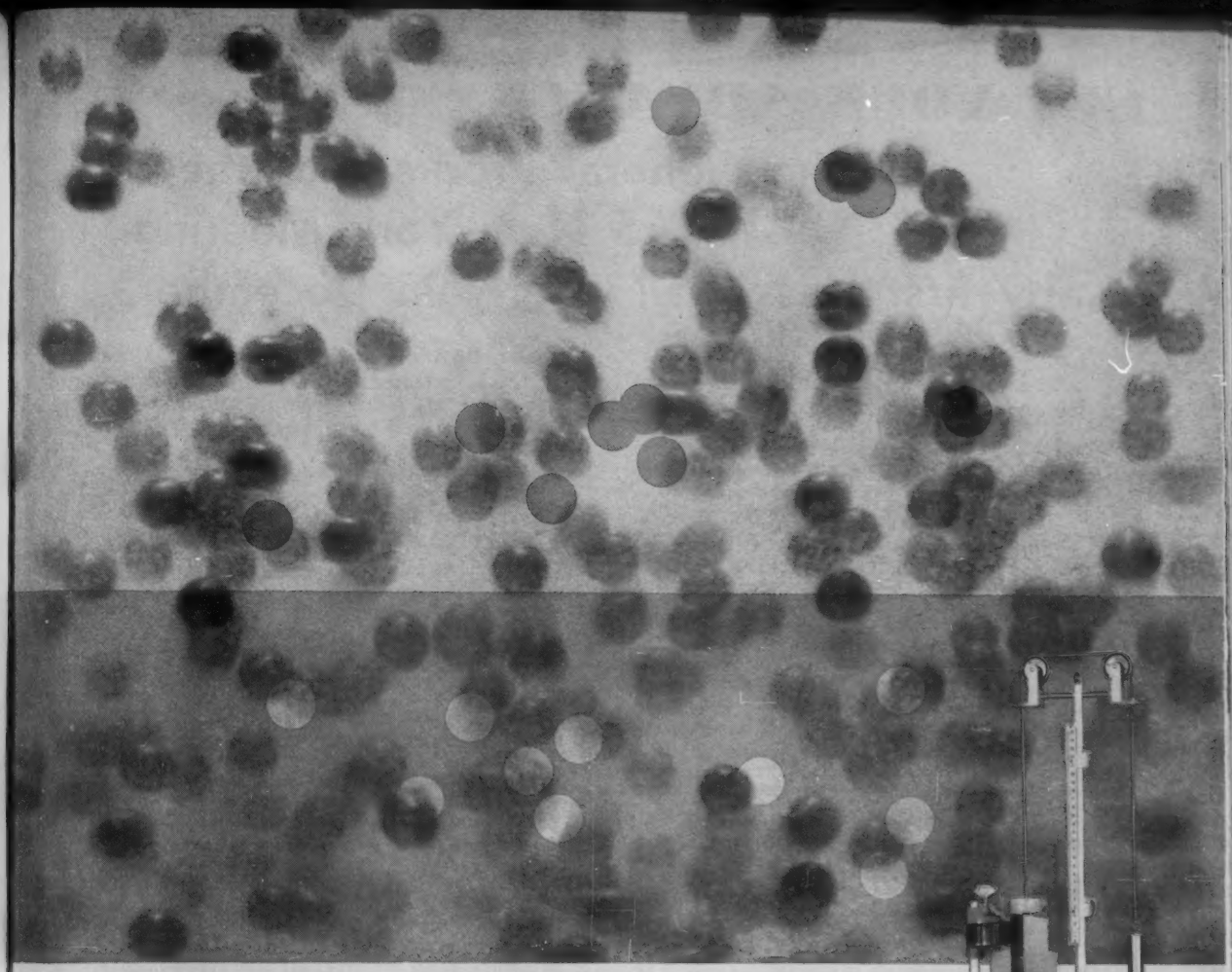

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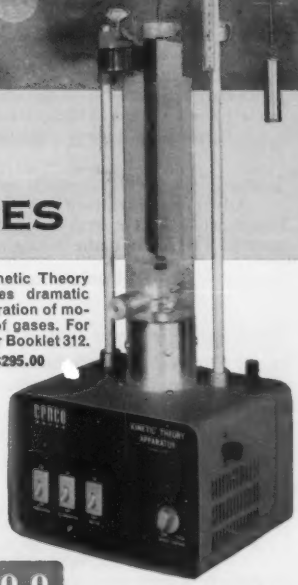

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of the General Program of the AAAS New York Meeting by first class mail – early in December

The General Program of the 127th Meeting of the AAAS in New York, 26–31 December 1960, will be available to you, at cost, within the first week in December—whether you can attend the Meeting or not.

Program Content

1. The two-session AAAS General Symposium, "Moving Frontiers of Science V"—Speakers: Edward Anders, H. W. Magoun, George Wald, and H. H. Goldstine; Thomas Park, presiding.
2. The "Challenge to Science" evening with Sir Charles P. Snow, Theodore M. Hesburgh, and W. O. Baker; Warren Weaver, presiding.
3. On "AAAS Day," the three broad, interdisciplinary symposia—Plasma: Fourth State of Matter; Life under Extreme Conditions; and Urban Renewal and Development, arranged by AAAS Sections jointly.
4. The Special Sessions: AAAS Presidential Address and Reception; Joint Address of Sigma Xi and Phi Beta Kappa by Polykarp Kusch; the Tau Beta Pi Address; National Geographic Society Illustrated Lecture; and the first George Sarton Memorial Address by René Dubos.
5. The programs of all 18 AAAS Sections (specialized symposia and contributed papers).
6. The programs of the national meetings of the American Astronomical Society, American Nature Study Society, American Society of Zoologists, History of Science Society, National Association of Biology Teachers, Scientific Research Society of America, Sigma Delta Epsilon, Society for General Systems Research, Society for the Study of Evolution, Society for the History of Technology, Society of Systematic Zoology, and the Society of the Sigma Xi.
7. The multi-sessioned special programs of the American Association of Clinical Chemists, American Astronautical Society, American Geophysical Union, American Physiological Society, American Psychiatric Association, American Society of Criminology, Association of American Geographers, Ecological Society of America, Mycological Society of America, National Science Teachers Association, New York Academy of Sciences—and still others, a total of some 90 participating organizations.
8. The four-session program of the Conference on Scientific Communication: The Sciences in Communist China, cosponsored by the AAAS, NSF, and ten societies.
9. The sessions of the Academy Conference, the Conference on Scientific Manpower, and the conference of the American Council on Women in Science.
10. The sessions of the AAAS Cooperative Committee on the Teaching of Science and Mathematics, and of the AAAS Committee on Science in the Promotion of Human Welfare.
11. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
12. Exhibitors in the 1960 Annual Exposition of Science and Industry—103 booths—and descriptions of their exhibits.

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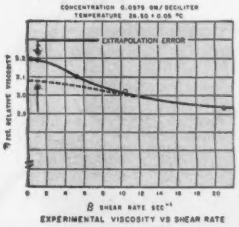
Viscosity Range.....Up to 800 centipoise at 0.2 sec.$^{-1}$
Accuracy.....±0.5% of sample viscosity
Cylinder Temperature.....Constant to within 0.05°C of desired temperature when located in a temperature-controlled (±2°C) room



EXPERIMENTAL VISCOSITY VS SHEAR RATE

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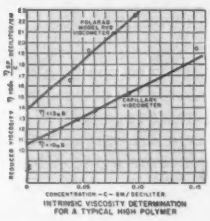

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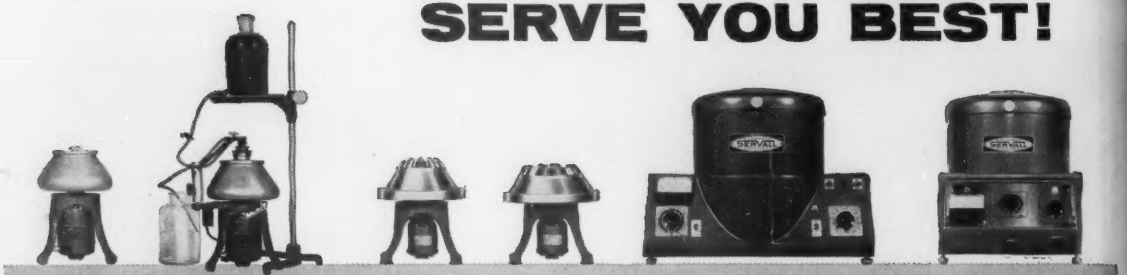

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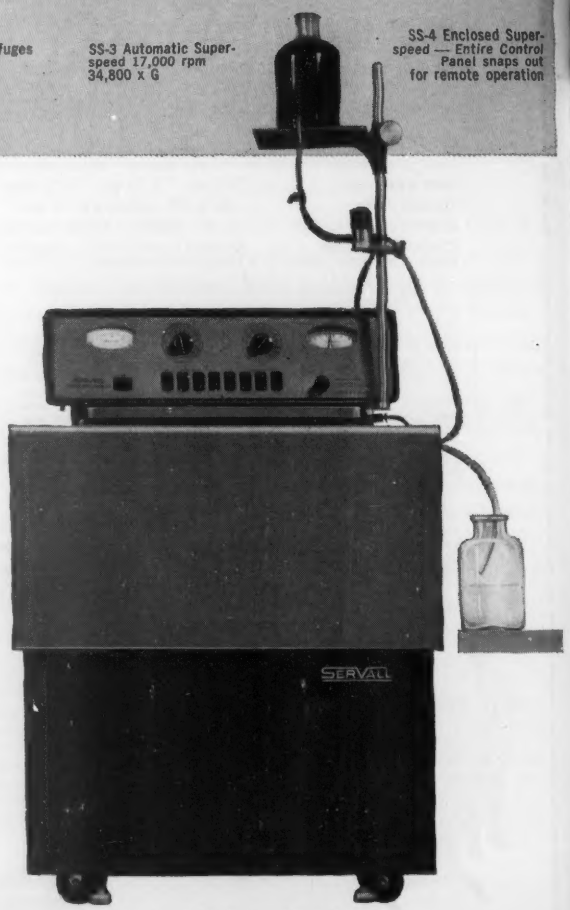

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When Boys Will be Buys

John Hersey's new novel, *The Child Buyer* (Knopf), finds no cause for universal rejoicing in this country's growing interest in the nurture of high intelligence. A satirical comedy, in which unfolds a bud of horror, the novel pushes one aspect of this interest to its ultimate conclusion. A child buyer, Mr. Wissey Jones, comes to a small New England town to attempt to purchase for his corporation a ten-year-old boy, Barry Rudd, who gives promise of transcendent scientific ability. The purchase is to be part of the corporation's far-sighted efforts in behalf of national defense. The story is told in the form of testimony before a State Senate committee investigating the purchase, and this enables Hersey to get in some licks at the conduct of government hearings. In fact, many facets of present-day America, from TV to JD, come under scrutiny, but the focus of the attack is the education, and place in society, we accord the gifted.

That segment of America which is coming to regard intelligence as a national resource is only part of Hersey's grievance. The novel also has its quota of professional educators of the personal-adjustment philosophy, and examines what they have to say about Barry. In modern educational theory, as in those quotations that occasionally serve to fill out *The New Yorker's* columns, the straight doctrine is often its own satire. Only a punch line is needed. To the educationists, Barry Rudd, as a gifted child, falls into the same category as the mentally retarded and physically handicapped. He is exceptional, but modern theory has it that any child is exceptional who is not centrally located on the normal distribution curve. To miss the mark is to miss the mark, whether to the right or the left. A few persons, as Hersey's State specialist in deviants points out, are even exceptional twice over, like Lord Byron, who was both gifted *and* clubfooted.

Although the educationists regard Barry as exceptional, they do not believe he should be singled out for special attention. That would be undemocratic. His place is in the classroom with other future citizens of the same age. Wissey Jones, on the other hand, wants to give Barry special treatment, also in the name of democracy—its defense. But he does not see Barry as a person either, only as a piece of valuable property. And once in the hands of the corporation, Barry will be treated as property not only economically but physically as well. He will be engineered in such a way, including major surgical attention, that his innate abilities will be able to function unhampered by doubts or distractions. This kind of special preparation, of course, is expensive, but as testimony before the committee brings out, the facility where the work is done is classified as an institution of higher learning—Hack Sawyer University, named after the company's president—so that the program is tax-deductible.

Barry is not at the university yet, however. It is first necessary to get the consent of his parents and also of his teachers, a few of whom are sufficiently independent to regard the boy as exceptional in the old-fashioned sense. But Wissey Jones is something of a genius himself, at least in public relations, in persuading people to accept a point of view. For some of the opposition to the scheme, persuasion consists simply in presenting attractive but unusable gifts, like a matched set of lightweight luggage for a man with no occasion to travel. For others, making the reward fit the crime is more complex, and requires a little experimentation. Barry's consent also proves necessary, and the final note of horror hinges on Jones' efforts to get it. The book is funny, it is grim. It is a kind of antidote to that poison in our thinking which treats scientific activity—and persons—as components in a system geared to larger ends.—J.T.

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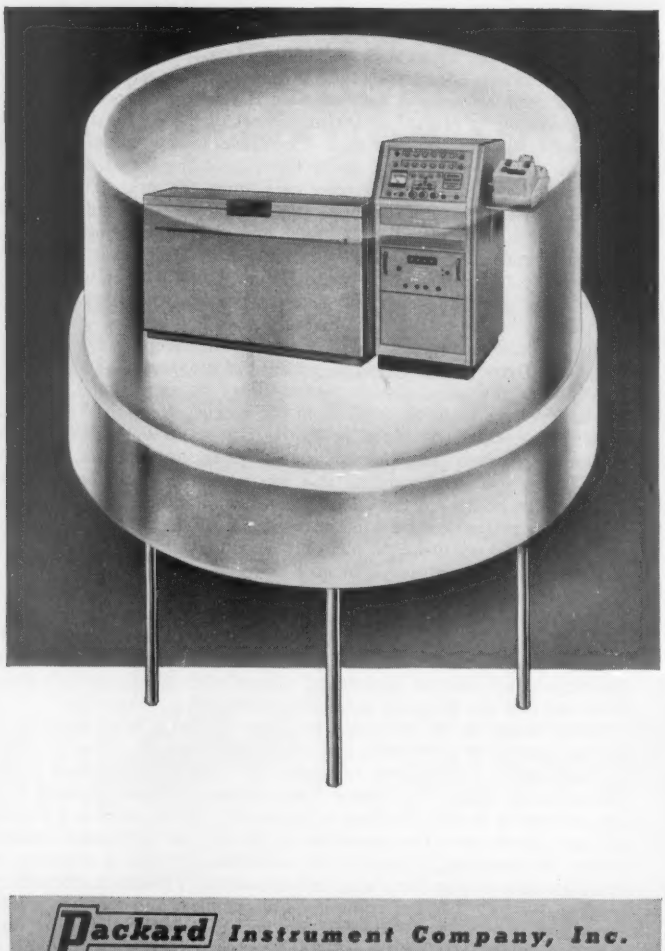

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CURRENT PROBLEMS IN RESEARCH

Desert Geomorphology in the Arabian Peninsula

Distinctive land forms provide new clues to the Pleistocene and Recent history of a desert region.

Donald August Holm

Discovery that natural resources of oil and minerals abound in desert regions is the reason for the recent penetration of the great deserts; it has resulted in learning how to cope with the problems of living and working in an arid environment. Exploration in general has accelerated rapidly since World War II, and in the case of the deserts, modern explorers have discarded the ancient modes of living and moving through these regions. The camel has been supplanted by the motor car, the powerful tractor truck, and the airplane; the simple wool tent has been displaced by air-conditioned trailers and portable living quarters. Water supply for exploration has been taken out of the realm of the chance finding of isolated water holes and placed on a dependable basis with the aid of hydrogeology, drilling, and pumping equipment. Mapping by the traditional methods has been reinforced by aerial photographic coverage and geodetic controls. Photogeology has become an important tool for the field geologist, enabling him to check and identify the geology of critical areas on the ground and to carry out mapping operations in greater detail and with pin-point thoroughness.

The author is a senior geologist with the Arabian American Oil Company, Dhahran, Saudi Arabia.

In early stages of exploration in Arabia, two- or three-man surface geology field parties moved through the country with Badawin guides, but as exploration advanced, other methods were utilized. The shift from the small surface geological party to the large structure-drilling group meant a substantial increase in the logistics problem. Transportation of drilling units and their accompanying camping equipment across great distances of difficult terrain required knowledge of the surface of the area penetrated. Today, as drilling and geophysical crews carry out their programs in the Rub' al Khali (one of the largest sand deserts in the world), they are drawing on the knowledge gained by their predecessors during the last 27 years. In addition, their problems can be simplified by systematic studies of terrain and trafficability preceding their entry into the unknown parts of the Rub' al Khali. The earlier approach to the problems of logistics, with the ever-present need to get to the next location, was the necessarily pragmatic approach of trial and error.

In the pragmatic process one learns something of sand dunes in the course of getting trucks stuck in the sand, and something of the saline flats on the Persian Gulf coastal plains, where such flats can engulf the unwary driver and his truck without warning. Hard experience with soft sands and *sabkhah*'s (saline flats on coastal plains) taught field men to recognize the danger of these invitingly smooth sand plains and to avoid them for more passable terrains.

In general, though reports assessing oil potentials leave little room for geomorphic description, over the years, in the moving back and forth across the sand and rock areas of the peninsula, the details of land forms have come to fit together and the broader questions of origin have gradually emerged.

In the present stage of accumulated information, many of the geomorphic problems in the Arabian peninsula present more questions than answers: What factors contribute to the emplacement of large sandy deserts? What causes the great variety in sand-dune shapes? What factors control the size of dunes? Can the movement of sand be controlled by applying knowledge of the natural behavior and characteristics of the moving sand itself? What causes broad gravel plains in Arabia? How old is the Persian Gulf and what features are identified that are pertinent to its geomorphic history? How do *sabkhah*'s form? Did the main wadi systems that dissect the steppes of the Najd once flow westward instead of toward the east?

These and other questions constantly badger the field men as they move across the surface of the peninsula, aware of the details but without time to integrate them into a whole. Let us consider some of the facts that have been observed in connection with these problems.

The Emplacement of Large Sandy Deserts

At least one-fourth to one-third of the land area of arid regions is covered with sand. The Arabian peninsula, with a total area estimated at 1,060,000 square miles, has sand cover on at least 300,000 square miles. The Rub' al Khali alone has an area of 230,000 square miles. The interior *nafud*'s (*1*) and the

Dahna make up most of the rest (see Fig. 1). Why do these *nafud*'s accumulate where they do?

Aeolian processes are active today and probably were active during times following glacial maxima in the Pleistocene. There may have been alternations of dry and moist climates. In support of this assumption, the discovery of the remains of *Hippopotamus* (*2*) and water buffalo in deposits underlying sand dunes in the southwestern Rub' al Khali indicates that there was a moist climate preceding deposition of the sand dunes. Whether this was a Pleistocene or an earlier climate is at the moment not known. Observation of dune patterns in two widely separated areas suggests that at least two dune cycles have been in operation: (i) in the western Rub' al Khali south of Wadi Dawasir, and (ii) in the north central Dahna, north of Rumah.

Where do these large sandy deserts occur? In the Arabian peninsula they are found in areas of low relief, frequently in long, narrow, low plains bounded by scarps and dip slopes (in the Najd) or in broad basins of low relief like the Great Nafud and the Rub' al Khali (*3*, *4*). Why does sand accumulate on plains? Probably gravity has as much to do with it as the wind. Dunes, as a rule, do not form on elevated landscapes, because of a principle, stated by Bagnold (*5*, p. 201), that "the rate of removal or deposition per unit area at any point on the surface is proportional to the tangent of the angle of inclination of the surface at that point." This is true whether the slope is on a dune or a hillside. An increase in angle of slope increases the wind velocity and the capacity of the air to carry sand. A decrease in angle of slope causes a drop in velocity so that sand is deposited. Sand is carried upslope over mountains and through passes and deposited on the slopes below. As long as the tangent of the angle of slope is negative, there must be deposition. Thus, sand is more easily deposited on descending slopes and low places than on uplands.

The sources of sand for the *nafud*'s and Rub' al Khali have been, and still are, numerous. The primary sources are crystalline rocks exposed in the uplands of the peninsula. From them, wadis carry alluvium to flood plains and deltas in the lowlands, where aeolian processes winnow out the sand and transport it. Strand lines of lakes and the sea are other potential primary sources of sand. Secondary sources are outcrops of sandstones upwind from dune fields and gravel plains in which unconsolidated clastic sediments are partly protected by the veneer of gravel, often a rich source of sand. Dune fields also lose sand to others downwind. The wind thus assumes a major role in the distribution of sand and its concentration in *nafud*'s and other sandy deserts.

The wind regime of the Arabian peninsula is complex in detail but simple in the broad view. The region lies within the trade-wind belt of the Northern Hemisphere. Westerlies from the Mediterranean enter the region in the northwest and travel toward the Persian Gulf and then swing south and southwest through the Rub' al Khali, toward the Yemen. The air masses of the shamal (*6*) appear to divide south of the Trucial Coast along the 53rd meridian, part bending off to the southeast, the rest back to the southwest. The effect of the monsoons is in the opposite direction, providing a reversal of winds for the southern Rub' al Khali at least.

The wind regime in the Najd is less well understood, primarily for lack of information. However, the *nafud*'s in the north central Najd respond to a wind regime that encompasses winds from every point on the circle, with formation of dome-shaped dunes, pyramidal dunes, and many variations of the sigmoidal dune (*4*). In the eastern Rub' al Khali, a similar regime gives rise to thousands of pyramidal dunes.

Twice a year, in December–January and May–June, the shamal season of northwest winds occurs. The length of the shamal season varies from year to year but may range from a few days to 50 or more. It is similar to the khamsin of Egypt. The shamal is familiar to all residents of the Persian Gulf region as the time of year when the air is filled with dust and sand. The winter shamal is less noticeable because of cooler and moister weather. The main movements of sand in the coastal plains of the Eastern Province appear to occur in the shamal seasons, with a rate of 38 percent of the total dune movement for the year (*7*).

The spring wind regime is complex. In the Najd it is extremely variable in direction and intensity, ranging from southwest to all parts of the compass and from zephyrs to storms and gales. The Rub' al Khali likewise has a variable spring wind regime, with easterly zephyrs alternating with southeast gales and shamals. In the southeastern Rub' al Khali field parties report winds from all directions. Occasional gales arise with velocities up to 75 miles per hour. The periods of high winds are those in which mass movements of aeolian sand are greatest.

The Great Nafud receives winds dominantly from the west, but there are less frequent reversals from the east, and locally within the Nafud there are occasionally winds of variable direction. Little is known about the Great Nafud and its climate. Observations about it are derived almost entirely from an examination of the dune patterns on aerial photographs.

Broad sandstone outcrops that lie upwind and west of the Great Nafud supply sand. The Dahna and the *nafud*'s west of it apparently derive sand from the Great Nafud and are nourished, in addition, by the alluvial deposits brought down by Wadi ar-Rimah to the region between Buraidah and 'Unayzah. The gravel plains bordering Wadi al-Batin have contributed sand to the dune areas south of them. The southern Dahna, the Jafurah, and the western Rub' al Khali have all been nourished by material from gravel plains. The Rub' al Khali probably derives sand from highlands on three sides, as well as from the coastal dunes and beach deposits of the southern Persian Gulf.

What we know of the wind regime for the peninsula, scanty as the data are, points to sand accumulation in two large basins, with elongate *nafud*'s connecting them, and additional concentrations in the coastal areas downwind from the Persian Gulf.

The Great Variety of Dune Shapes

A study of aerial photographs of sand-dune regions in Arabia reveals a large variety of dune shapes. The variety and complexity of dune patterns in the Rub' al Khali is far greater than is generally realized (Fig. 2). The *nafud*'s of the Najd have dune complexes that appear to be peculiar to that region (*4*). The Great Nafud has the unique crescentic hollows described originally by Blunt (*8*) (Fig. 3). There are also linear complexes and simple transverse dunes, with a few scattered pyramidal dunes in the southeastern part. The Dahna, with its great arc more than 1200 kilometers in length, has had a complex history, which has affected dune shapes. Its north-central part is perhaps most interesting. Here there are sigmoidal dunes (*9*), tuning-fork dunes, linear dunes, and pyramidal dunes (*10*) in a perplexing array.

The most important factor in the shaping of dunes is the wind and its pattern, with the relative supply of loose sand next in importance. A change or shift in the wind shifts sand, either removing it or depositing it. The shape of a dune changes constantly while the dune bulk is increasing or waning. A slight change in the dune surface shifts the course of the sand stream. Shifting winds are more effective than constant winds in producing variety of dune shape. Turbulence appears where wind streams are mixed by passage over or around an obstacle. Turbulence is a very effective tool of dune sculpture, whether acting at high or low velocities.

Streamlined flow in one direction tends to build barchan dunes. Reversal of the wind direction tends to destroy the barchan by cutting off the top of the slipface and building a new one with a convex arc down wind on the back of the old one. Shifting the wind to a side quarter tends to shift the dune sideways, intensifying the slipface on the windward horn and rounding it off on the leeward horn. A shift to 45° tends to elongate the opposite horn [contrary to Bagnold (5, p. 223)] to form an incipient linear dune. If the winds are alternating, roughly equal, and from opposite directions, the barchan is transformed into a sigmoidal dune (Fig. 4).

Pyramidal dunes form from sigmoidal dunes when the winds beat around the compass. If a sand-laden wind intensifies from one quarter, it will modify pyramidal dunes into incipient giant crescents, by piling sand on the windward side. Under slightly different conditions (perhaps lower velocities), small sigmoidal dunes detach themselves from the pyramidal dune and migrate across the floor. The process of sigmoidal dunes merging with and detaching from the pyramidal dune is one of the most fascinating actions in the desert.

The sigmoidal dune joins in other ways to form linear dunes of great complexity. One of the most peculiar and unique is the "hooked dune," so-called from its resemblance to a fishhook or a shepherd's crook. Badawin of the south-

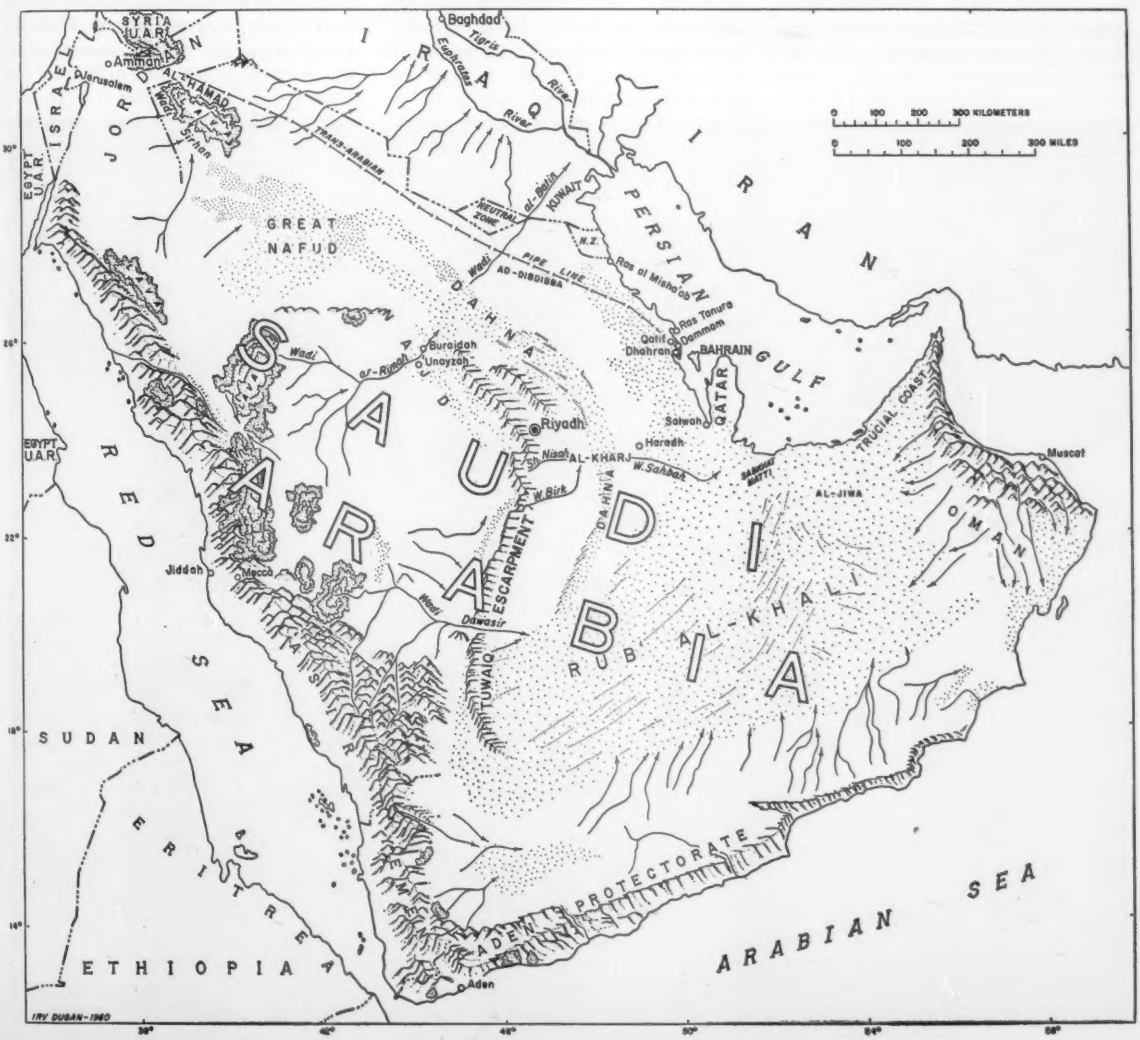

Fig. 1. The Arabian peninsula.

ern Rub' al Khali, where this form occurs, call it "curved or wandering," with such names as *'irq ma'kuf*, *'irq muta'akkif* or *'irq muhayyar*, drawn from resemblances to the curled tail of the saluki dog (*11*). The hooked dune has two parts, a long sinuous sigmoidal ridge, forming the shaft, and a well-defined crescent, forming the hook. The hooked dune in the Rub' al Khali is usually oriented with the shaft pointing down wind or southwest. There is a gradual change in form and complexity of the hooked dune as one goes toward the northeast. The shafts or linear elements become shortened to the length of a kilometer or less, and the slipface widens and joins with several others to form a double or triple hook. The physical relief of this variety of the hooked dune is greater than in the simpler forms, and the dunes are spaced much closer together. The hooked dune is the product of north, northeast, and southeast winds, in that order of importance. It predominates in the southern Rub' al Khali and is not known elsewhere in Arabia.

Other dune complexes too numerous to describe are the giant crescentic massifs of the Jiwa area (Fig. 5), dome-shaped dunes (*4*), long linear complexes of sigmoidal ridges in branching or coalescing patterns, chevron-shaped ridges in linear belts, pyramidal dunes shaped like four-pointed paper pinwheels, and the ubiquitous rolling transverse ridge without slipface, called by the Badawin *zibar*, which is present in many interdune areas and which in the central Rub' al Khali is a dominant form. It is out of order to include the *zibar* in dune complexes, but it was mentioned in this connection, because it is a form of low relief that develops in between many complexes and, in particular, in the low areas between linear belts. *Zibar* forms a hard, smooth sand surface traversable by motor vehicles.

The shape of dunes is also affected by the presence or absence of moisture and vegetation. Rainfall may saturate the dunes to a depth of half a meter. This is enough to germinate seeds or spores if the air temperature approaches 80°F. Water works upward by capillary action into the bases of dunes from *sabkhah* floors beneath, or into dunes from underlying aquifers. Where the moisture supply is relatively constant, perennial shrubs with long roots can establish themselves. Sand areas with moisture and vegetation lose the definite and clean forms of dunes and become intricate hummocks and narrow passages of erratic shape.

The presence of certain shrubs or xerophytic plants is indicative of camel-grazing lands, and many parts of the desert have been named by Badawin accordingly. The names also indicate

Fig. 2. Transverse and linear dune complexes, due to frequent wind changes, and exploration party camp in eastern Rub' al Khali. Aerial view looking northwest. [Arabian American Oil Co.]

something of the topographic form. Thus, *zibar* is rolling, trafficable, smooth, firm sand, without permanent vegetal cover. *Marbakh* is similar in form but carries a scattered cover of a perennial shrub, *'abl* (*Calligonum comosum*) and occasionally a sedge (*Cyperus conglomeratus*) called *'andab*. *Marbakh* tends to deflate slowly and thus loses relief, in comparison with barren sand dunes nearby. Shrubs on the side slopes of pyramidal dunes and large linear complexes tend to stabilize the slope until they are covered by freely moving sand. Every obstacle in the path of the sand stream deflects the stream and is a potential cause of a change in dune shape.

The spacing and relief of dunes are contributing factors to the shapes of dunes. Low relief causes less turbulence in the air stream than high relief, and therefore less change in dune form.

The equilibrium of a sand dune is like a delicate chemical state of equilibrium; the slightest change in the conditions involves changes in the state of equilibrium. Studies in petrology and sedimentology of aeolian sands and investigations of micrometeorology of the air stream passing over dune surfaces are recommended.

The size of dunes varies greatly. There does appear, however, to be a limit of maximum height for any given dune field. The limiting factors have been discussed by Bagnold (*5*, chap. 12).

The size of dunes is not always governed by the shape, as there are small crescentic dunes a few meters high, and tens of meters wide, and others of similar shape a hundred times as large. Pyramidal dunes are seldom less than 50 meters in height and range up to more than 150 meters, with diameters of 1 to 2 kilometers. Sigmoidal dunes vary from tiny sharp ridges, a few meters high to huge ridges 100 meters high. Tiny "tear-drop" dunes 10 to 15 meters in diameter are found along the southern boundary of the Rub' al Khali (Fig. 6). These are so small that they are not resolvable on aerial photographs with a scale of 1:60,000, though on photographs of scale 1:10,000 they may be studied in detail. A broad band of long, high parallel linear dunes ('uruq) (*12*) forms the southern part of the Rub' al Khali westward of the 50th meridian; it is called " 'Uruq al-Qa'amiyat" (Fig. 7). The ridges attain heights of 100 meters or more, stretch to lengths of 20 to 200 kilometers, and are usually 1 to 2 kilometers wide. The upper surfaces of the ridges are covered with a complex of branching linear and sigmoidal dunes, where local relief is usually less than 50 meters. Dune massifs in the eastern Rub' al Khali with heights of 500 to 700 feet (153 to 213 meters, are reported by Thesiger (*13*). Unverified verbal reports of dunes with heights of 1000 feet (330 meters) have been received, but to date, no surveyed heights greater than 200 meters have been recorded.

Dunes in the Great Nafud have been reported by field parties to be 100 meters high and described as gigantic (*14*). I have surveyed pyramidal dunes in the north central Dahna with heights of 150 to 170 meters.

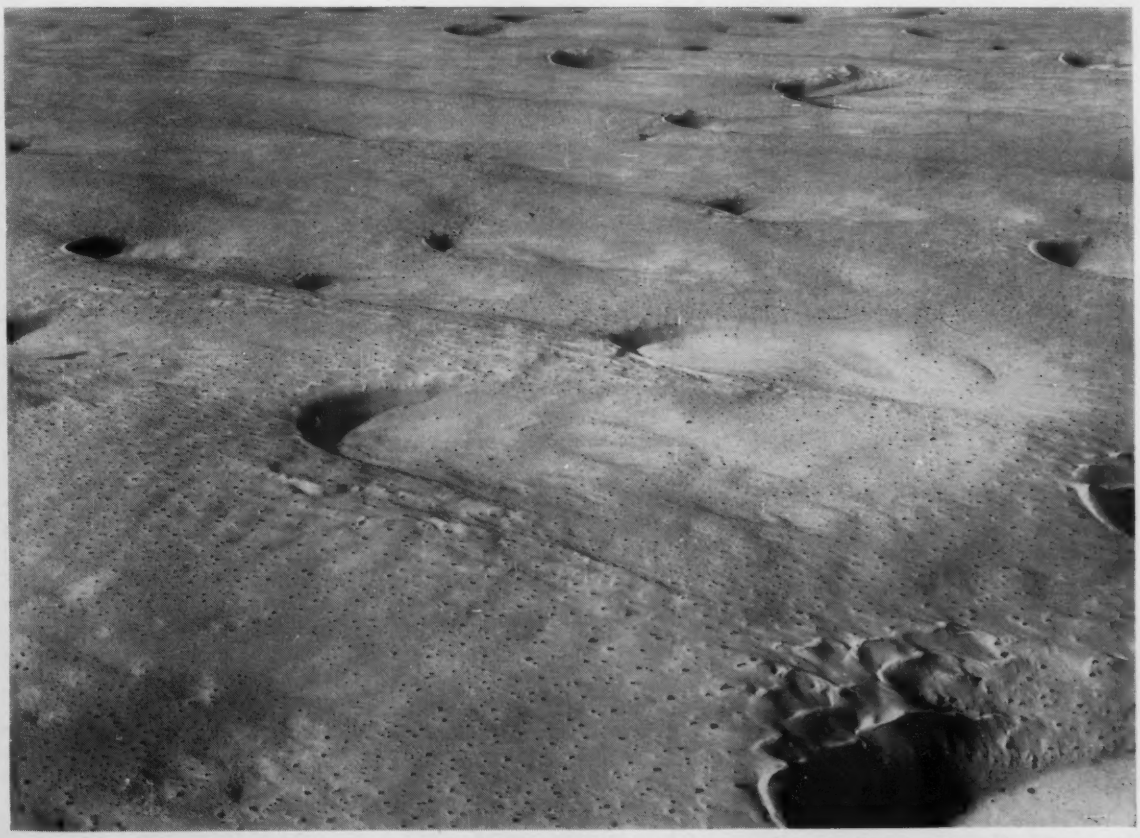

Fig. 3. Giant crescentic hollows and slipfaces in the Great Nafud, looking northwest. [Arabian American Oil Co.]

Sand Control

The problem of sand control may become crucial where industrial installations, houses, power lines, roads, railroads, walls, airstrips, and communities have been built in the path of moving aeolian sand. The immediate problem is that of protecting installations from influx of drift sand. No less important is the matter of stabilizing or breaking up sand dunes before they encroach upon an installation.

Utilization of plant cover to stabilize sand is an old, well-known method, much publicized in Europe, and used by Arabs near Buraidah for several hundreds of years. Plant control is hardly feasible in many arid lands for lack of water. Artificial procedures have been devised, such as sand fencing, based on the principle of the snow fence, and the oiling of sand dunes and surfaces with a high-gravity, waxy, penetrating oil (*15*).

Geomorphic methods of sand control have been suggested by Barclay (*16*) and Bagnold (*5*, pp. 36, 71, 153–159, 169, 170, 180, Fig. 53). Both propose spreading gravel or pebbles on a sand surface to reduce sand movement. Bagnold advocates spreading pebbles on dunes as a method of "killing them." Actually, any material the size of pebbles, such as loose aggregates, shells, broken glass, pottery, or cinders, and even dry camel dung will serve the purpose.

Origins of Gravel Plains

Gravel plains in Arabia are either alluvial or residual.

Alluvial gravel plains may be divided into several kinds: (i) river deltas; (ii) river flood plains; (iii) intermittent stream flood deposits; (iv) fans; and (v) bolson deposits.

Residual gravel plains are the product of weathering and deflation of conglomerates.

There are also regoliths, or residual stone desert plains, where there has been no transportation of pebbles or cobbles but concentration in place by weathering and deflation of cherty limestones or similar rocks composed of hard and soft materials.

The climate of Arabia today is so arid (less than 100 millimeters of precipitation annually) that integrated river systems capable of flowing to the sea are practically nonexistent. The wadis in Pleistocene times were undoubtedly less intermittent than today, and a few of them apparently reached the sea. Among the latter, the Wadi ar-Rimah–Wadi al-Batin system (continuous, although the former is now clogged by *nafud*'s) is one of the larger systems, reaching from headwaters in northwest Najd to the Tigris-Euphrates Valley in southern Iraq.

The Rimah-Batin Wadi system, during one of the major pluvial periods of the Pleistocene, apparently carried rushing floods loaded with rock debris, eroded from the crystalline uplands and the sedimentary steppes of the northern Najd. The floods cut narrow, steep-walled canyons through limestone plateaus and then, as the floods spread out on the coastal plains, dropped their loads in a great, delta-shaped area called ad-Dibdibba, which reaches from its apex at 28°N and 45°30′E almost to the southwest edge of the Tigris-Euphrates Valley. The surface of this triangle is a gently sloping gravel plain, bisected by the trough of the present-day Wadi al-Batin. The gradient across this plain is 1.2 meters per kilometer. Its surface is covered with gravel trains divergent from the apex toward the outer edge. Other gravel beds have been observed in the valley walls of Wadi al-Batin, and also in wells drilled through the gravel. Cobbles and pebbles show a gradual decrease in size toward the outer edge. The materials that compose them are quartz, igneous rocks, metamorphic rocks, and limestones, with finer sediments interspersed. Deflation by winds has smoothed the plain into a very flat, gently undulating surface, veneered with gravel, and when dry, it is traversable by vehicles in any direction. Because of the deltaic shape, the distribu-

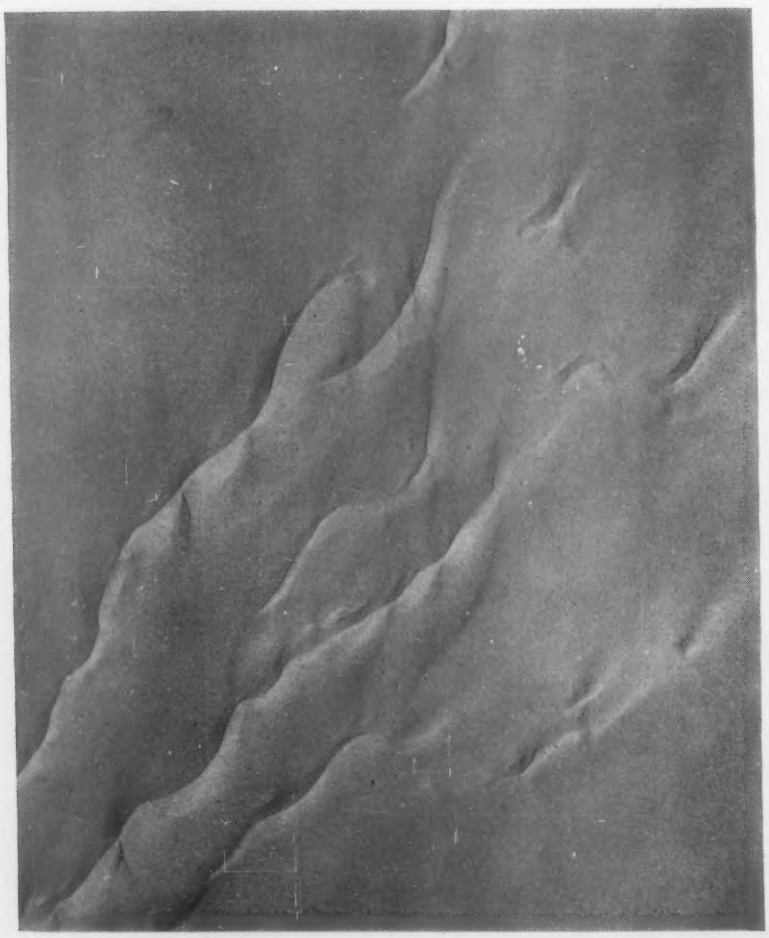

Fig. 4. Sigmoidal dunes in the southwest Rub' al Khali. [Arabian American Oil Co.]

tion of alluvium, and its position between a wadi system and the coastal plain of a hypothetical Pleistocene Sea, the plain is classified as a delta.

The Nisah-Sahbah wadi system—which drains the central Tuwaiq Plateau, runs eastward just north of the 24th parallel, and breaks out of the confines of the interior steppes at Haradh—has deposited a similar gravel plain with even more marked characteristics of deltaic origin. The apex is at Haradh, and from this point a series of divergent gravel trains fan out toward the Persian Gulf. The margins of the plain have been indented by subsequent inroads of the sea, but aerial reconnaissance has enabled us to trace some of the gravel trains across Qatar and around the southern end of Qatar to the western edge of Sabkhat Matti. The gradient across this plain varies from 1.02 to 0.88 meter per kilometer. The trench of a younger Wadi Sahbah (now choked with sands of the Jafurah) cuts across the plain from Haradh southeastward and out to the Gulf just southeast of Qatar. The gravel trains are protected from deflation by the concentration of cobbles and pebbles in the ancient channels, so the trains now stand a few meters above the surrounding plains as inverted courses. The marginal areas of the plain show the results of dissection by a younger cycle of erosion, and this has been more drastic than dissection of the Wadi al-Batin delta. The shape of the plain, approaching that of the Greek letter *delta*, and the divergent fanning of gravel trains, along with the grading of sediments toward the Persian Gulf, suggests that this, too, can be classified as a delta. The presence of foreset beds of sands and silts at several places along the margins beneath the gravels further suggests a deltaic origin.

A third wadi system, that of the Wadi Dawasir, has deposited a broad, gently sloping gravel plain, parts of which reach to the southern borders of the Sahbah delta near Wadi Jaub. The analogy is suggestive, but as the Dawasir plains are largely covered by sand dunes of the northwestern Rub' al Khali, the origin remains questionable at present. Philby (*17*) suggested that Dawasir and perhaps other systems in the southwest in previous times may have reached across the intervening areas to the Persian Gulf.

River flood plains in Arabia are less conspicuous than the deltaic plains. The ancient course of Wadi al-Atj, which drained the northern Tuwaiq plateau and departed from the steppes near Ma'aqala, left gravel trains, deposits of red and brown sands, and other alluvium (now erratically exposed where erosion has uncovered them) in a widening band that extends northeast from Ma'aqala almost to the southern edge of ad-Dibdibba plains. The Pleistocene history of this wadi system is obscured by sand dunes and recent deposits which cover its lower reaches. The evidence does not fully support the existence of a deltaic plain, but does suggest the possibility of a flood plain.

There is another gravel feature, the Wari'ah gravel ridge, which is quite a puzzle. This ridge is about 100 kilometers long and 1 to 2 kilometers wide and extends east and west, along the southern margin of ad-Dibdibba. It is protected from erosion by the heavy cover of coarse-to-medium cobbles and pebbles, and it stands about 10 to 20 meters above the surrounding plain. F. S. Vidal and I found a few crude, rolled artifacts in the gravels in 1958. Wari'ah seems to be the remains of an old stream course heading east, but very little else is known of it.

Many long, narrow, and smooth gravel plains are found below the Tuwaiq, Dhruma, Khuff, and Tawil escarpments that can be classified as intermittent stream deposits.

Fans frequently develop where intermittent streams debouch from steep scarps onto flatlands below. There are many recent fans below the Tuwaiq scarp. Gravel fans which have been separated from the parent scarp are found on the south side of Wadi Sahbah, east of al-Kharj. These are composed mainly of limestone debris, derived from uplands to the south. (I

Fig. 5. Giant crescentic dune complex, 2 to 5 kilometers across, in northeast Rub' al Khali. [Arabian American Oil Co.]

found a single, crude, rolled artifact of quartzite there in 1953.) Alluvial fans and pediments form around the bases of mountains in the crystalline complex of the Arabian shield, where relief and steep slopes are adequate for their formation.

Bolson deposits accumulate in enclosed basins with centripetal drainage. There are thousands of centripetal basins in Arabia, in sedimentary rocks as well as in the crystalline basement. I am most familiar with those found in the sedimentary areas, where relief is moderate and the dry lakes in the basins have reached maturity as silt flats. The Arabic name for these silt flats is *khabari* (singular, *khabra*). Gravels are seldom visible except in the margins, but where they are exposed by erosion, they are seen to underlie the silts, occasionally in several layers.

Residual gravel plains are formed from the weathering and deflation of conglomerates. The Biyadh plain, which extends southward from Wadi Sahbah to Wadi Dawasir as a white, quartz-pebble plain, has been derived from a quartz-pebble conglomerate and sandstone which has been weathered and deflated in place. A similar plain covered with quartz-pebbles is located southwest of Majma'a in the Sudair region of the northern Tuwaiq.

The residuum left by the weathering and erosion of cherty limestones in al-Hamad in northwest Arabia forms plains sometimes miscalled gravel plains. As the residual chips of chert have not been transported by water but merely became concentrated in place by removal of the softer matrix, the terms *regolith* or *residuum* seem more applicable. Al-Hamad forms the stony plains of the great Syrian Desert, a truly inhospitable region to the traveler in the old days before motor cars and deep-water wells were available.

Gravel plains are significant in the deserts for several reasons. One is important to the modern exploration geologist. Gravel plains may cover broad areas of rock formations he wishes to explore. This means that structure drilling and geophysical methods of exploration are required, with greater demands on the budget. Another reason is that gravel plains are good trafficable surfaces for motor transport, and airstrips for light aircraft are easily prepared.

Fig. 6. Tear-drop dunes, small sigmoidal dunes, barchans, and an elliptical dome-shaped dune with smaller dunes streaming off down wind. Winds from north northeast and east southeast. Southern Rub' al Khali. [Arabian American Oil Co.]

Age and Geomorphic History of the Persian Gulf

The absence of terraces on the Arabian side of the Persian Gulf is conspicuous. There are, however, traces of higher stands of sea level in the form of shell beds, serpulite reefs, and calcarenites, at several levels. East-facing cliffs in the Eastern Province, as opposed to west-facing cliffs in the Najd, and possible wave-cut benches on Jibal Dhahran, on Jabal Barri, and in the southwestern part of Qatar suggest the possibility of higher sea levels in Recent or Pleistocene times. Lees (*18*) mentions terraces on the west side of the mountains of Oman at 1230 feet (and mentions that the northern end of this mountain range, the Musandum Peninsula, is submerged, forming a drowned coast). The coast lines of the Eastern Province and Trucial Coast are largely "emergent." Shingle, in what appears to be a beach remnant near Nibak at the eastern edge of the Sahbah deltaic gravel plains, stands at an elevation of about 110 meters.

Sabkhah's (*19*) (discussed below) are found inland from the coast at elevations up to 150 meters near Hofuf. *Sabkhah*'s are being formed today along the coast by aeolian sand filling embayments. If the high *sabkhah*'s are formed by the same process, it is logical to assume that there were embayments of the Gulf at the higher levels.

The lowest of the shell beds is found 1.5 to 2 meters above sea level, along the coast between Ras al-Misha'ab and Salwah, and again along the Trucial Coast. It appears to be undisturbed by movements of the crust. It may be equivalent to wave-cut benches in rock in the harbor at Maskat, at a similar low level. The bench in the Eastern Province carries abundant small *Tur-*

ritella-like shells and serpulite reefs. It is quarried for light aggregate, used in roofing and in seal-coating of asphalt paving in Dhahran. Cornwall (*20*) may have had this level in mind in his assumption of a recession of 5 to 10 feet in historic times. More accurate dating of this shell horizon would be helpful.

The next higher marine deposit is a calcarenite composed of miliolites, calcareous pellets, and quartz sand, interbedded with dune sands. The calcarenite is cemented by calcium carbonate. It forms low cliffs along the shore from Ras Tanura to Ras al-Misha'ab. Remnants of the formation are found on the northeast side of Jabal Barri, in the vicinity of Qatif, and at Jabal Muraiqibat, south of Dammam. It forms stacks and islands as well as part of the coastal plain of the Trucial Coast. It laps on the Tertiary surface of al-Baynunah, south of the Trucial Coast. Farther north, it borders remnants of *sabkhah*'s in the area east of Hofuf and in Wadi al-Miyah. Beds of the calcarenite have been found in cores taken at Ras Tanura (Najma), and it is thought to dip under Recent deposits on the floor of the Persian Gulf.

The calcarenite has been given an informal name, "Bahr formation," from its first observed occurrence in Jabal Bahr, offshore from the village of Jubail (*21*).

The Bahr formation, in addition to the outcrops mentioned above, underlies sand dunes on the coastal plain between Ras al-Misha'ab and Ras Tanura. Its presence can be detected by the occurrence of white calcareous or quartz sands. When the Safaniyah-Ras Tanura pipeline was constructed, Bahr formation was exposed frequently by the ditching machine. It was found bordering some of the *sabkhah*'s which extend inland from the coast, and in other areas where its presence was suspected, holes bored with a post-hole auger were used to determine its presence. White dunes, derived from the Bahr formation, occur commonly from Dhahran southward to Salwah and are sharply differentiated from dunes of the Jafurah by the change in color from white to golden tan.

There are references in the literature (*22*) to occurrences of a miliolite of Pleistocene age, on islands in the Persian Gulf and on the coast of Maskat. It would be interesting to know if these are correlative with the Bahr formation.

Further study and mapping of the Bahr formation would clarify Pleistocene history of the Persian Gulf.

The evidence for a higher stand of Persian Gulf waters provided by east-facing cliffs and wave-cut benches needs careful study. The exact relationships of these features to possible marine sediments of Pleistocene age are not known. An advance of the sea to the base of these cliffs at an elevation of at least 150 meters is clearly possible. Evidence for tilting towards the

Fig. 7. 'Uruq al-Qa'amiyat in southwestern Rub' al Khali, looking northeast. [Arabian American Oil Co.]

north is suggested by north-south alignment of *sabkhah*'s, with slopes inclined gently to the north.

The deltas of the Wadi al-Batin and Wadi Sahbah systems seem to indicate the possibility of an even higher advance of the sea at an earlier stage of the Pleistocene. The elevation of the apex of the Batin delta is 400 meters, and at the outer edge the elevation is approximately 100 meters—a difference of 300 meters in 250 kilometers, or a gradient of 1.2 m/km. The gradient of the floor of Wadi al-Batin is 1.12 m/km, too low for water to flow except in periods of very heavy rainfall. Water stands on the surface of the gravel plain and only flows for a short time after very heavy rains, when low places have been filled to overflowing. This seems to suggest the possibility that slight tilting to the southwest has reduced the gradient from that at the time the delta formed. A much steeper gradient than 1.2 m/km seems necessary for the transport of cobbles of the size found in the gravels.

A similar situation exists in the Sahbah delta. The elevation at the apex near Haradh is 300 meters and at the edge of the delta at Khashm Umm Huwaidh the elevation is 110 meters, a difference of 190 meters in 185 kilometers, or a gradient of 1.02 m/km. From Haradh to another point on the edge of the delta, near Ras Mushayrib where the elevation is 35 meters, the difference is 265 meters in 300 kilometers, or a gradient of 0.88 m/km. Again, the gradient seems too low for the transport of the cobbles found at the delta margin, so the question arises, "Was there tilting to the west and, if so, how much?"

A summary of geomorphic features suggests the possibility of higher stands of sea level in the Eastern Province of Saudi Arabia. These features are: (i) a low-level shell-and-serpulite bench; (ii) outcrops of the Bahr formation from sea level or below to 150 meters above; (iii) *sabkhah*'s from sea level to 150 meters above; (iv) wave-cut cliffs and benches inland; and (v) deltas of probable early Pleistocene wadis.

How Do Sabkhahs Form?

The *sabkhah* problem has two interesting aspects—one, purely geomorphic in the genesis of a coastal land form; the other, the relation of the *sabkhah* to the deposition of salts and evaporites intercalated with sediments in thin layers.

The *sabkhah* is a saline flat. The name is from the Arabic, and use of the term should be restricted to coastal regions. Saline flats in the interior basins, akin to playas of the American Southwest, are known by another Arabic word, *mamlahah* (*19*). The *mamlahah*, though often classed as a dry lake, differs from the type of interior basin called *khabra*, which has no salts or evaporites but is filled entirely with silts.

There are two types of *sabkhah*'s on the Arabian coast: (i) arenaceous, filled with sand, and (ii) argillaceous, filled with clay. The arenaceous *sabkhah* is formed by the filling with aeolian sand of an embayment of the sea and by the reworking of this sand filling by waves and currents. The process can be observed today south of Dhahran at Dohat Dhalum, particularly on a windy day. Many of the *sabkhah*'s along the coast show growth lines in subparallel arcs, marking former positions of the shore line. The surface of the arenaceous *sabkhah* is quite flat and smooth, with low gradients, of less than 0.5 m/km. During dry periods, capillary water in the sand evaporates and concentrates to a very saline brine, with eventual precipitation of salts near the surface. After rains, water stands on the surface, owing to saturation and high-tide levels. Water level subsides in dry weather to 0.3 to 1.0 meter below the surface. Water rising through pore space in the sand coats the grains, increases lubrication, and develops into a soft quicksand of low bearing strength. Evaporation of standing water on an arenaceous *sabkhah* forms salt crystals as a coating on the surface and sometimes forms a thick armor plate of salt. If this salty armor is buried by aeolian sand, it may be preserved until dissolved by a rise in water level.

Argillaceous *sabkhah*'s are formed as the result of the manufacture of calcareous mud by algae or other organisms in shallow coastal embayments. The process can be observed in Tarut Bay, and in the coastal *sabkhah*'s near Khursaniyah. The mud is wet, soft, and sticky, has very low bearing strength, and flows under pressure. Aeolian sand blown across the surface sticks to the mud and forms a layer seldom more than 1 meter thick. A layer of dry sand 1 meter thick, lying on soft mud, will support the weight of a moving light truck. Once wet, the sand softens, like quicksand, so that a heavy vehicle, and sometimes a light one, will sink through until it rests on its frame. A thin sandy crust may appear to be safe but should be tested carefully before one tries to drive out upon it. The surface layer of an argillaceous *sabkhah*, when not covered by sand, dries in summer heat. Where packed by traffic in the roadways, it hardens to the consistency of asphalt. Away from the roadways, the surface is generally unsafe, whether wet or dry.

Argillaceous *sabkhah*'s occur between Tarut Bay and Ras al-Misha'ab and are also numerous on the Trucial Coast. Sabkhah Matti, one of the largest in Arabia, is a compound *sabkhah*, both sandy and argillaceous. In both regions there are *sabkhah*'s with a surface which appears to be only mud but which, on testing, proves to be underlain by a firm subcrust. The latter may be a strong, thick layer of salt or gypsum or, more rarely, a layer of hardpan.

The *sabkhah* as a depositional source of salt, particularly in the case of intercalated layers of salt and sediment, receives little consideration from chemical theorists on salt formation. It is not unlikely that some ancient saline deposits, such as Permian red beds and salts, may have been formed in an environment similar to that of the *sabkhah*. I recall examining the cores from a wildcat exploratory well in eastern Arizona, with nearly 400 feet of intercalated red sandstone, siltstone, and salt. No layer was more than 1 foot thick, despite the fact that recovery of the core was high (*23*).

Tilting of the Arabian Craton

It is generally assumed that the Arabian Craton was tilted toward the sedimentary basin now occupied by the Persian Gulf through most of geological time since the Precambrian. Historical geological evidence supports this concept. However, in probable Pleistocene times, when the great wadis cut their courses in several limestone plateaus, several major wadi channels were cut through the Tuwaiq plateau, leaving canyons that are wider at the western ends than at the eastern ends. Wadi Birk, Wadi Dawasir (in the south), and three troughs cut through the central Tuwaiq—namely, Sha'ib Nisah, Sha'ib al 'Ausat, and Sha'ib Lihah—are all wider at the

western ends than at the eastern. It has been assumed, as normal, that these wadis flowed eastward toward the Gulf. Were the notches, shaped like gigantic *V*'s, cut at the western ends of these canyons the results of normal stream erosion cutting into a dip slope that dipped downstream? Or did the streams originate in Tertiary times as west-flowing rivers, when the Afro-Arabian shield had not been uplifted?

In conclusion, the desert geomorphologist today finds that the desert is susceptible to systemic land-form analysis. Every land form in the desert has significance, if we can but determine what it means. Desert geomorphologists of the future, many of whom may come from the Middle East, will discover that there are still geomorphic frontiers in the Arabian deserts (*24*).

References and Notes

1. *Nafud* is the Arabic word for a large sandy desert, used mainly in the Najd.
2. A lower right molar tooth of *Hippopotamus* was found in 1955 by William Reiss, in the southwest Rub' al Khali, in beds underlying the dune sands. It resembled a specimen of *H. antiquus* in the Heidelberg Museum. Leakey, of the Coryndom Museum, Nairobi (personal communication), suggested that it might be identified as *H. gorgops* if more of the skull, with eye sockets, could be found. The specimen has disappeared from the Arabian American Oil Co. collections.
3. See map No. I-270-B-1 of the Arabian Peninsula (1:2,000,000) in *Miscellaneous Geological Investigations*, published (1958) by the U.S. Geological Survey and the Arabian American Oil Co., under the joint sponsorship of the Kingdom of Saudi Arabia and the U.S. Department of State, and maps Nos. I-213-B and I-214-B (1:500,000) in the same series (1959).
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24. This article is published by permission of the Arabian American Oil Co. General statements on climate and winds are derived from the company's meteorological records on file in Dhahran and from personal observation. Grateful acknowledgment is made to my colleagues, particularly G. P. Crombie, E. L. Elberg, Jr., L. F. Ramirez, and N. M. Layne, for many valuable discussions; to O. A. Seager, for support of this study; to I. A. Dugan for the sketch map; and to my wife, Esther A. Holm, for critical editing.

Specific Transport of Oxygen Through Hemoglobin Solutions

Why is this transport abolished when opposed by a slight back pressure of oxygen?

E. Hemmingsen and P. F. Scholander

It has recently been shown that under certain steady-state conditions oxygen moves several times faster through hemoglobin solutions than through water. In these experiments the solution was held in a Millipore membrane, above which was air at varying pressures and below which was moist vacuum. It was found that the nitrogen flux in all cases was strictly proportional to the diffusion pressure, but that the oxygen flux was enhanced. At air pressure of 1 atmosphere the oxygen-nitrogen ratio was almost double that of water, and at 1/12 atmosphere it was eight times higher than that of water. The following simple numerical relation prevailed in each case: Total oxygen flux = oxygen diffusion + a constant. Or, to express it more empirically: Total oxygen flux = nitrogen diffusion × 0.56 + a constant, where 0.56 is the O_2/N_2 ratio in the hemoglobin-free solution.

This was interpreted to mean that the oxygen flux proceeds via two separate routes—namely, a simple Fick's diffusion through the solution and a specific transport which is mediated by the hemoglobin. The latter is constant over a wide pressure range, increases with the concentration of the hemoglobin until the viscosity becomes excessive, and is abolished when the pigment is oxidized to methemoglobin. Suspensions of intact red cells and solutions of myoglobin show a similar effect (*1*).

These results were obtained by a gasometric technique which required that a near-vacuum be maintained below the membrane; it could not be used to study gas flow into a system containing oxygen of various tensions. In a muscle, zero or near-zero oxygen tension is relevant enough, but this would very rarely apply to the blood. The question therefore presented itself: What happens to oxygen transport through hemoglobin when the low pressure is elevated? In order to answer this question a new approach was needed, and it was highly desirable, also, to determine the state of oxygen saturation in the membrane at various pressures.

The authors are members of the staff of the Scripps Institution of Oceanography, University of California, La Jolla.

Methods

Determination of gas flux against back pressure. A Millipore filter charged with hemoglobin solution was used to separate two large volumes of oxygen or nitrogen gas. When a pressure difference was applied, gas permeated the filter and the steady-state flux was determined.

Two 300-cm³ gas chambers were moistened with a little water and interconnected through a capillary measuring device and a diffusion chamber (Fig. 1). The latter was divided into an upper and a lower half. The Millipore filter, resting on a rigid stainless steel screen, was clamped, airtight, between them. The graduated capillary, of 1- to 2-millimeter inside diameter, held a drop of kerosene for measuring the rate of gas flux. The drop could be reset at any time for repeated measurements by means of a three-way stopcock. Adequate sensitivity was obtained by keeping the gas volume between the drop and the membrane small (1 cubic centimeter). Change in the water content of the membrane by evaporation and condensation was the greatest source of error and was minimized by inserting a ring of wet filter paper in the lower diffusion compartment. The whole apparatus was immersed in a thermoregulated water bath.

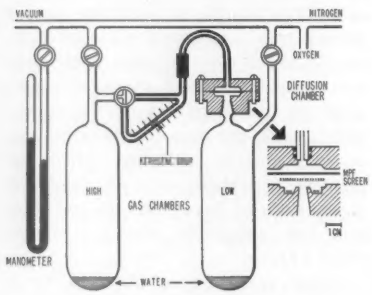


Fig. 1. Diffusion apparatus.

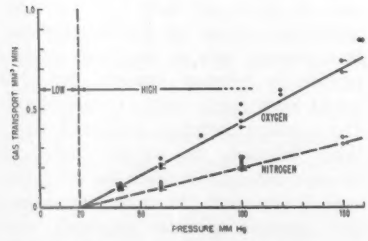


Fig. 2. Flux of oxygen and nitrogen through hemoglobin solution at an oxygen back pressure of 20 mm-Hg. Oxygen capacity, 20 to 21 vol percent. The marked points belong to sequences taken on two membranes. The other points are mostly single determinations from various membranes.

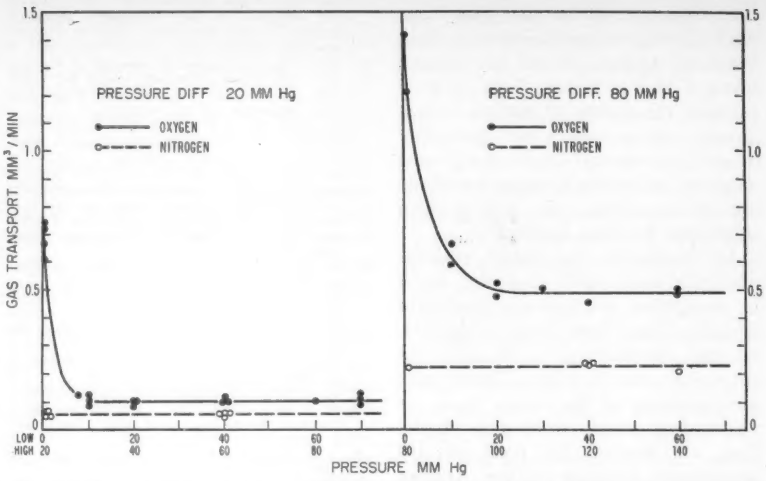


Fig. 3. Flux of oxygen and nitrogen through hemoglobin solution at constant pressure gradients but varying absolute pressures. Oxygen capacity of solutions, 20 to 21 vol percent. (Right) Two membranes at *p*H 7.2; (left) four membranes at *p*H 7.2, 7.3, 8.2, and 8.5, respectively.

Hemoglobin solutions were prepared from heparinized human blood, and the Millipore filter was charged with the solution, as previously described (*1*). With the membrane clamped, airtight, in the diffusion chamber, the system was evacuated and filled with purified oxygen (or nitrogen), evacuated again, and refilled. The desired pressure on the high and low sides of the membrane was obtained by means of the manometer. With the stopcock set as in Fig. 1, the rate of gas flux through the membrane was determined from the rate of movement of the kerosene drop. Final readings were taken when steady-state flux was reached. For each membrane the gas flow was determined at several different pressures, first with oxygen gas, then with nitrogen gas.

Determination of oxygen saturation in membrane. A membrane charged with hemoglobin solution was suspended in a flat plastic chamber which was kept moist with a strip of wet filter paper. The air spaces on each side of the membrane communicated with each other, and the air was maintained at various pressures. The state of oxygenation at each pressure was read on a reflectance spectrophotometer.

Two different series of experiments were performed in order to determine the effect of back pressure on the oxygen transport. In the first series the low pressure stayed constant at 20 mm-Hg, while the high pressure varied from 30 to 150 mm-Hg (Fig. 2). It may be seen that the transport of both nitrogen and oxygen proceeds exclusively by simple diffusion; that is, the rate is proportional to the gradient, and the oxygen moves nearly twice as fast as the nitrogen; there is no enhancement of the oxygen rate.

In the second series the total gas pressure varied while the pressure difference was maintained constant, either at 20 or at 80 mm-Hg (Fig. 3). It will be seen that the rate of *nitrogen* flux closely reflects the fourfold difference in gradient, and looking at each run separately, we find that the rates are constant all the way down to zero pressure; that is, the nitrogen moves by simple diffusion. In the case of *oxygen*, however, simple diffusion prevails only down to opposing oxygen pressure of 10 mm-Hg. Below this, the flux increases rapidly and reaches a maximum at zero back pressure; that is, the specific transport mediated by the hemoglobin is abolished when it is opposed by a slight back pressure of oxygen.

This blocking effect by oxygen is specific, for neither water-vapor pressure of 20 mm-Hg (moist vacuum) nor the addition of nitrogen to a pressure of 80 mm-Hg impedes the flux. The specific oxygen transport appears

to be insensitive to temperature, for there was no clear difference in the oxygen-nitrogen ratio in runs made at 15° and 25°C. Likewise, there was no *p*H effect (compare Fig. 3, left), although such an effect becomes manifest at very low oxygen pressures (*1*).

The state of saturation of a membrane suspended in air at various pressures may be seen in Fig. 4. Full oxygenation occurs down to pressures of 30 to 25 mm-Hg, and one may therefore assume that our diffusion membranes were fully saturated, or nearly so, in the surface layer down to air pressure of ⅛ atmosphere. Similarly, it can be seen that the blocking pressure of 5 to 10 mm-Hg corresponds to less than half saturation of the lower surface. Evidently, therefore, a maximally accelerated oxygen transport requires full reduction pressure on one side of the membrane and full saturation pressure (or more) on the other.

When the hemoglobin solution in the membrane was solidified by gelatine, the nitrogen diffusion remained unchanged but the specific oxygen transport was cut in half (*1*). This suggests that the oxygen transport is linked with the kinetic motion of the hemoglobin molecules. One concept would assume that a certain exchange of oxygen takes place from one hemoglobin molecule to the next when these collide. At the vacuum end of the chain there is no more than one oxygen molecule attached to the hemoglobin. When this molecule is lost to the vacuum, the deficit or "hole" is filled in from above; that is, the disturbance is transmitted through the entire chain in a rate-limited "bucket-brigade" fashion (*1*).

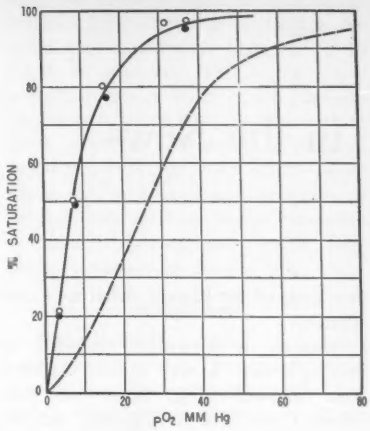


Fig. 4. Saturation of a membrane suspended in air at various pressures, measured by reflectance spectroscopy. (Left) Observed curve measured on two different membranes at 23°C, *p*H 7.3 and no carbon dioxide; (right) reference curve (37°C, *p*H 7.4, carbon-dioxide pressure, 40 mm-Hg) (*3*).

An alternative view would be that the transport is caused by oxyhemoglobin diffusing from one surface to the other. The porosity of the Millipore filter is much too fine for convection to take place, but hemoglobin readily diffuses into much finer structures, such as agar gels. Hence, some of the oxygenated molecules might carry oxygen downward and unload it to the vacuum, but if this is the case, an equal number of empty molecules would be moving upward, and one would expect these to receive oxygen from the loaded descending molecules. As in other countercurrent systems, such a cross exchange would strongly limit the net transfer. This concept is in line with the relatively low efficiency of our system. But neither of the proposed systems explains why a slight back pressure of oxygen should completely block further unloading.

What role does this hemoglobin transport system have in human beings? Presumably very little, if intact red cells are as sensitive to back pressure as is hemoglobin. If, however, the blocking pressure is related to degree of saturation rather than to absolute pressure, the transport might still be effective under tissue asphyxial conditions wherein the carbon dioxide tension and the presence of lactic acid have lessened the oxygen affinity (*2*).

References and Notes

1. P. F. Scholander, *Science*, **131**, 585 (1960).
2. This investigation was supported by a research grant (No. RG-5979) from the U.S. Department of Health, Education, and Welfare, Public Health Service. We wish to thank John Tyler for his help in making the reflectance measurements and Denis L. Fox for his stimulating suggestions.
3. F. J. W. Roughton and J. C. Kendrew, Eds., *Haemoglobin* (Interscience, New York, 1948).

Science in the News

The New Administration: It Faces a Number of Questions of Scientific Policy; No Easy Solutions in Sight

The new administration is committed to taking strong action immediately after inauguration to put through its program for expanded efforts in education, defense, agriculture, civil rights, and several other areas. But in the field of science policy the problems are less susceptible to legislative or administrative blitzkrieg.

Some indication of the direction of the new administration will be evident in the revised budget proposals it will submit soon after taking office. The requests for research funds should show an increase over the last Eisenhower proposals. But the deeper problems of developing policies and mechanisms for carrying out a coordinated national program of scientific research are expected to be developed gradually, partly through a process of trial and error, as the administration struggles to find its way.

There are several points at which the new administration may wish to change the direction of Eisenhower policies. Two of them, possible revisions of an Atomic Energy Commission report published last week, are discussed below. But there will be a great deal of continuity.

Science Advisory Committee

The President's Science Advisory Committee, the highest-level organization for dealing with questions of science policy, has a reputation for being singularly nonpartisan. It is almost universally regarded as an extremely valuable organization, and a group like Senator Jackson's National Policy Machinery Subcommittee, which will shortly begin issuing a series of reports highly critical of Eisenhower's methods of dealing with policy questions and the way he has used such bodies as the National Security Council, apparently has found little to criticize about the workings of the Science Advisory Committee.

Because it is widely regarded as having worked so well and having been free of partisanship, the Science Advisory Committee is singularly free of worries over problems of transition to the new administration that have troubled so many other government bodies. George Kistiakowsky, chairman of the committee, made it clear before the election that he would leave the government in January. But the new top Presidential science adviser is expected to be someone well known to the committee and its staff, indeed probably a member of the present committee.

A measure of the committee's nonpartisanship was suggested when a member was identified in the press as a top science adviser to Kennedy. In almost any other area of the government a man publicly associated with the anti-administration candidate would have been promptly asked for his resignation. In this case the man voluntarily offered his resignation, but it was promptly turned down by Eisenhower. Almost anywhere else but on the Science Advisory Committee it would be regarded as unthinkable for a man to be simultaneously on the staff of the President and on the staff of the opposition candidate.

Multidisciplinary Efforts

Some of the questions the Science Advisory Committee has been struggling with and will continue to struggle with in the months ahead are how to organize support for multidisciplinary efforts such as oceanography (*Science*, 27 May) for which responsibility is fragmented among a number of different agencies and which therefore have a tendency to get lost in the shuffle under current methods of budgeting and presentation of programs to Congress; how to assure an adequate level of support for expensive, high-priority programs while assuring adequate support for less glamorous but still very important fields (this problem comes up, for example, in working out programs to support the very expensive work in high-energy physics while still assuring adequate support for low-energy physics). Another side of this general problem is to assure a reasonable balance remains between support for physical and biomedical sciences and support for the social sciences and the humanities.

In another area, there is general agreement on the need for making the Federal Council on Science and Technology a more effective agency for gaining cooperation throughout the government on national science policy. The two, the President's Science Advisory Committee and the Federal Council, are parallel organizations, both part of the executive office and both headed by the science adviser to the President. Both are quite young. The organization of the council was announced at the AAAS annual meeting in December 1958, and it has been in operation only about a year. The President's committee, itself, has been a really important organization only since the increased concern with science was developed as an aftermath of sputnik.

Federal Council

The President's committee advises the President on policy; the Federal Council's major function is to enlist the support of the agencies of the government in carrying out the policies that are decided upon, a far more difficult task than is commonly realized, for government agencies have numerous ways of dragging their feet in carrying out presidential decisions.

Beyond the problems that lie specifically in the area of science, there is the feeling that a more efficient method of budgeting has to be evolved in order to improve the efficiency of the government in general. Budgeting consumes a major part of the time and energy of top officials. In areas like scientific research and foreign aid the present year-to-year budgeting procedures make it difficult to make the long-term commitments that nearly everyone feels should be made. In areas like oceanography, where programs are fragmented among many agencies, it is impossible to present a unified program to Congress, and the bits of the program must be considered by many different Congressional committees, few of which have the knowledge to understand the importance of the segment that comes

under their consideration as part of the over-all program. Reorganization of budget procedures has been talked about for years, without much progress being made. It will be a major accomplishment if the new administration can put it across in the course of the next 4 years.

AEC Report

Two questions of scientific policy the new administration will face were suggested by an Atomic Energy Commission report published last week sketching the expected role of the Commission's national laboratories over the next 10 years. The report was not intended to represent a firm commitment, which would be premature even without the extra uncertainty over what the new administration will do. But it represents a useful yardstick against which to gauge what is actually done in the years ahead.

AEC-sponsored research (not including weapons research) now runs to well over $600 million a year. Two-thirds of the money is spent in the AEC's 20 major national laboratories, which are run on a contract basis by an industrial company, a university, or a group of cooperating universities. The laboratories are owned and completely supported by the government. They represent an investment of over a billion dollars in equipment and buildings. Their staffs, though, are employees of the contract management rather than the government; this arrangement relieves the organizations of some of the restrictions, including salary limits, which would exist if the staffs were part of the civil service.

Volume of Research

The report suggests that the volume of AEC-sponsored research will grow with the growth of the national economy, but does not specifically suggest that the growth of research will be only proportionate to the over-all economic growth of the country. It can be assumed that investment in research both by the AEC and by other government agencies will grow considerably faster than the national economy; one of the tasks for the new administration will be to decide how much faster.

The Defense Department, for example, is spending only half as much money on basic research as its scientific advisory committees have been recommending. And when the Navy sponsored an attempt to calculate an optimum ratio of basic to applied research effort, its study committee decided that a ratio as high as 50/50 might be advisable. This would imply a basic research effort in the Defense Department about 10 times the current level. And the desirability of such an expanded effort in turn would imply the need for a strenuous program of federal assistance to higher education in order to develop the scientific manpower necessary to carry it out.

Federal Role

Aside from the problem of deciding on a proper level of investment in research, the new administration will be faced with deciding whether it will accept the present administration's view of the role of the government in promoting research, which has been to try to hold to a minimum the amount of work done in facilities owned by the government.

The AEC report on the future role of the national laboratories represents the view of the outgoing administration. It suggests that the government-owned laboratories are "mature" institutions not likely to grow very much, and that the bulk of the increased AEC-sponsored research in the years ahead will be done through contracts and grants to the universities and industry. The national laboratories would continue to carry a great deal of responsibility for basic research in fields such as high-energy physics, where enormous outlays are required for equipment, and for basic and applied research in high-priority areas where the group effort possible in the government-owned laboratories can produce results faster than the individual efforts of university scientists. Development projects, many of them involving improved types of reactors, would be handled in the national laboratories through the preliminary stages and then would be transferred to industry for advanced development as soon as it became economically and technically feasible to do so. But the relative importance of the government laboratories would decline as further investment in research was directed primarily toward industry and the universities.

This attitude may be revised by the new administration. There is general agreement on the wisdom of supporting basic research through the universities whenever possible, if only to strengthen the universities and their ability to turn out greater numbers of well trained new men. An especially fast growth is seen for AEC-sponsored research in the universities in the fields of basic physics and biomedicine. But there seems to be some difference of opinion over industry's future role.

Complaints are heard that the Eisenhower administration, always anxious to work through private industry rather than through government-owned facilities, has sometimes been premature in moving projects out of the national laboratories and into industry, although industry critics say that just the opposite is true.

There have been cases where projects have had to be taken back into the government laboratories for further development after it became clear that industry was not in a position to carry on the work.

One of the major national laboratories, for example, let a contract to an industrial firm to fabricate a new type of reactor fuel element. The assumption was that research and development problems had been solved to the point where the industrial company could deal with any further hitches. A year was wasted until the project was taken back into the national laboratory, where the facilities and personnel were on hand to solve the technical problems which had turned out to be more than the private company could deal with.

Pressure on Laboratories

Barring an increase in the size or number of the national laboratories, the number of new projects that can be undertaken will be limited by how quickly established projects can be moved to industry. This situation will put increased pressure on the laboratories to hand projects over to industry as quickly as possible. The present administration regards this pressure as desirable. But if the new administration should decide that this will lead to premature or inefficient transfers of responsibility, it may recommend an expansion of the government-owned laboratories beyond the modest expansion foreseen in the report. It may ask for greater expansion of the government-owned laboratories in any case if it becomes apparent that important projects are being shut out because the national laboratories, without expansion, cannot take them on and that industry, faced with the need for huge and hard-to-estimate investment in specialized facilities, cannot profitably handle them.—H.M.

News Notes

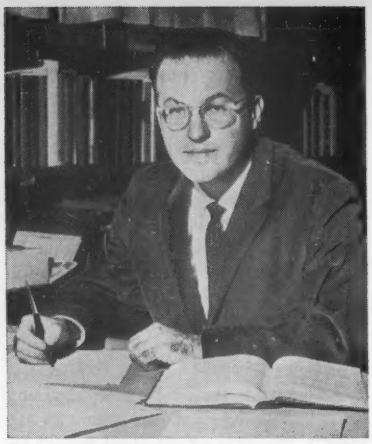
Libby and Glaser Win Nobel Awards in Chemistry and Physics

Two University of California professors have won Nobel Prizes in science. Willard F. Libby, 51, of the Los Angeles campus, will receive the chemistry prize, and Donald A. Glaser, 34, of the Berkeley campus, the physics prize. A check for approximately $43,700 will be presented to each man on 10 December during a ceremony in Stockholm that will similarly recognize Sir Macfarlane Burnet of Australia and Peter Brian Medawar of England, previously announced joint winners of this year's Nobel Prize in physiology and medicine.

The Royal Swedish Academy of Sciences, which administers the awards for the Nobel Foundation, announced that Libby is being honored for having developed a method of using carbon-14 for age determination. Glaser's prize-winning achievement is the invention of the bubble chamber, a device for studying subatomic particles.

In developing his "atomic clock," Libby found that all organic matter absorbs a certain definite amount of carbon-14. This disintegrates at a fixed rate, having a half-life of 5568 years. Therefore, by measuring the amount of radioactivity left in an ancient specimen, ages of from 1000 to 30,000 years can be calculated to within about 200 years. Libby, a member of the Atomic Energy Commission from 1954 to 1959, conducted his carbon-dating research after World War II, while at the University of Chicago.

Willard F. Libby



Donald A. Glaser

The Swedish Academy's citation for Glaser described two earlier Nobel Prize winning methods of elementary particle study, C. F. Powell's emulsion method and C. T. R. Wilson's cloud chamber method, then pointed out that Glaser had bridged the "wide gap in range" between the two techniques by evolving a process in which the nuclear particles leave traces in superheated liquids; these traces appear on photographs as "strings of fine vapor bubbles." The citation also said: "Mention should be made here of bubble chambers filled with liquid hydrogen which now render extremely valuable service. . . ." Glaser developed his bubble chamber at the age of 28, while he was on the staff of the University of Michigan.

This is the first time in the 60-year history of the Nobel awards that two scientists from the same university have won the chemistry and physics prizes simultaneously and exclusively.

New Standard of Length Adopted

At 6 P.M. Paris time on 14 October, during the 11th General Conference on Weights and Measures, the world adopted a new international standard of length—a wavelength of light—replacing the meter bar which has served as the standard for more than 70 years. The announcement was made from Paris by Allen V. Astin, director of the U.S. National Bureau of Standards and head of the American delegation to the conference. The new definition of the meter as 1,650,763.73 wavelengths of the orange-red line of krypton-86 will replace the platinum-iridium meter bar which has been kept at Paris as an international standard for length since 1889 under the Treaty of the Meter.

While not of general concern, the conference decision is of great importance to those engaged in precision measurement in science and industry. For many years the world has relied on a material standard of length—the distance between two engraved lines on the International Meter Bar kept at Paris. Duplicates of the International Standard were maintained in the standards laboratories of other countries of the world. From time to time it was necessary to return these duplicates to Paris for recalibration, and occasionally discrepant results were obtained in these recalibrations. Also, there was doubt in the minds of some scientists regarding the stability of the international meter bar.

The new definition of the meter relates it to a constant of nature, the wavelength of a specified kind of light, which is believed to be immutable and can be reproduced with great accuracy in any well-equipped laboratory. Thus it is no longer necessary to return the national standards of length to Paris at periodic intervals in order to keep length measurements on a uniform basis throughout the world. Also, it is possible to measure some dimensions more accurately in terms of the new definition than was possible before.

Measurement of Length Not Changed

The new definition of the meter will not materially change the measurement of length nor alter in any way the relationship between the English and metric units. Experiments performed at the National Bureau of Standards by the team of A. G. Strang, K. F. Nefflen, J. B. Saunders, B. L. Page, and D. B. Spangenberg immediately prior to the meeting confirmed that the wavelength standard and the metal standard are in satisfactory agreement. The inch now becomes equal to 41,929.399 wavelengths of the krypton light.

Similar measurements performed by the National Research Council in Canada, by K. M. Baird and his associates, are in substantial agreement with the National Bureau of Standards results. They all show that the distance from a point in New York to a point in Washington would be altered by less than three inches, as measured in terms of the old metal standard and the new wavelength standard. However, by adoption of the new definition, the standard of length which has been used by spectroscopists for the past 50 years

is brought into agreement with that used in other branches of science, thus increasing the unification of systems of measurement throughout the scientific world. Although the conferees recognized that the new definition may have the effect of shortening the meter, the amount of shortening will be less than 1/5000 the thickness of a dime.

Other Actions Taken in Paris

Other actions taken by the Paris conference included the establishment of a central facility at the International Bureau of Weights and Measures for international coordination of radiation measurements and confirmation of a new definition of the second of time. The establishment of a central international facility for measurement of x-rays, radioactive isotopes, and neutrons will assure that all nations of the world will be able to make coordinated measurements of these radiations. To accelerate the planning of this major effort to establish world-wide standards of radiation measurement, the Ford Foundation has made a grant of $32,500 to the International Bureau of Weights and Measures, which was accepted by the conference.

The conference also confirmed the action of the International Committee on Weights and Measures in defining the second of time as 1/31,556,925.9747 of the tropical year 1900, instead of 1/86,400 part of the mean solar day, and discussed the possibility of using atomic vibrations as standards for measuring time intervals.

Latin America Needs Journals; Appeal Made for Unused Issues

The Division of Science Development of the Pan American Union has organized a new program to help Latin-American scientific libraries and information centers complete their files of scientific journals. Latin-American libraries are being urged to become members of the U.S. Book Exchange and to request the journals they need through that organization's established procedure.

The Exchange is a nonprofit corporation in Washington that serves as a central office for the exchange of books and journals between libraries all over the world. It also receives and distributes contributions from individuals. Some 1800 libraries, more than half of them in foreign countries, are members. Approximately one and a half million items are exchanged annually, but requests often exceed supplies.

The Pan American Union's Division of Science Development has issued an appeal to U.S. scientists to send unused files of professional journals to the Book Exchange for distribution abroad. The division has also announced that if a Latin-American library has an urgent need for a specific journal which is not available in the U.S.B.E., the division will publicize that need through appropriate professional journals, suggesting that the journal be sent to the Exchange designated as a gift for the library in question.

The estimated value of a gift and the mailing costs may be claimed as income tax deductions. For further information, write to the U.S. Book Exchange, Inc., 3335 V St., NE, Washington 18, D.C., or to the Division of Science Development, Pan American Union, Washington 6, D.C.

Drosophila Stock Center To Be Established in Philadelphia

The Institute for Cancer Research, in Philadelphia, will establish a *Drosophila melanogaster* stock center. The center, the second one in the United States, will be under the direction of Irwin I. Oster of the institute's Division of Chemotherapy. The National Science Foundation has awarded $124,800 to support the new project for a 5-year period.

Some 2500 mutant strains of fruit flies will be maintained at the center. In addition to being used for research projects there, they will be available, free of charge, to researchers and teachers throughout the world. The stocks will be kept in groups of six vials each, so that cultures can be supplied to investigators at any time.

The new center will have duplicates of the 800 varieties of fruit flies currently maintained in the stock center at the California Institute of Technology. It will also have 600 stocks representing the major portion of the strains maintained at Indiana University, as well as 200 stocks maintained in the institute's department of genetics, and 800 strains consisting of other useful mutations obtained from other laboratories or synthesized by Oster and his staff.

The NSF grant also provides for the annual publication and distribution, through the Drosophila Information Service, of descriptions of the stocks and explanations and suggestions for their use. The publishing of periodic diagrammatic descriptions of existing and future stocks will serve to familiarize workers in the field with the latest techniques available for research in *Drosophila.*

Placement Services Being Surveyed

Some 200 privately supported associations concerned with higher education will soon receive from the U.S. Office of Education's Division of Higher Education questionnaires concerning the nature and extent of higher education placement services offered. The study covers placement for all academic and administrative positions. Findings will be published as a directory of higher education placement facilities, with a brief description of the study and an analysis of the problems in this area. The directory should be useful to colleges and universities, to faculty members wishing to secure or change positions, and to all higher education placement services.

The study was conceived jointly by the U.S. Office of Education and the American Council on Education. The current phase of the work is being conducted under the direction of Robert Poppendieck, specialist for teacher education, U.S.O.E. He urges that all private organizations which provide placement assistance and have not received questionnaires report to his office, Rm. 3760, U.S. Office of Education, Washington, 25, D.C., so that they may be included in the study.

News Briefs

Controlled thermonuclear reaction. An extremely brief, but controlled, thermonuclear reaction was announced on 4 November by Frederic H. Coensgen and his associates in the University of California's Lawrence Radiation Laboratory, Livermore. The achievement, which was reported during a meeting of the American Physical Society's plasma physics division in Gatlinburg, Tenn., is considered a major step in the search for an unlimited source of energy for peaceful uses.

* * *

Explorer VIII launched. The National Aeronautics and Space Administration announced that Explorer VIII was successfully launched from Cape Canaveral, Fla., on 3 November and is transmitting satisfactorily. A 90-

pound, "spinning-top" vehicle, this is the first of several planned satellites whose mission will be to chart the ionosphere above the 400-mile level. Explorer VIII is expected to stay in orbit for several years, but the transmitter is designed to operate for only 2 or 3 months.

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Science talent search. High school seniors throughout the country have been invited this month to compete in the 20th annual Westinghouse Science Talent Search for awards and scholarships totaling $34,250. Forty teen-agers judged in the Search as the nation's most promising future scientists will attend the 5-day Science Talent Institute in Washington, D.C., early next year to compete for five top scholarships. During their expense-paid trip to the institute, the national winners will exhibit their own research projects, tour government and private research centers, and hold discussions with many of the nation's leading scientists. Science Service, Washington, D.C., administers the Search through its Science Clubs of America. A record 29,000 students entered the competition last year.

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Ecological society of Australia. At a meeting of animal and plant ecologists recently held in Canberra, Australia, a new biological society—the Ecological Society of Australia—was inaugurated. The objectives of the society are similar to those of the corresponding bodies in the U.S. and Great Britain.

The society's officers are as follows: president, K. H. L. Key; secretary, J. H. Calaby; and treasurer, A. G. McArthur. There will be an annual general meeting each August and an additional meeting held in association with the annual meetings of the Australian and New Zealand Association for the Advancement of Science. For information, write to the secretary, Wildlife Section, Commonwealth Scientific and Industrial Research Organization, Box 109, Canberra City, A.C.T., Australia.

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Radio telescope delayed. Construction of the Navy's rotating radio telescope at Sugar Grove, W. Va., has been delayed at least 2 years by unexpected engineering difficulties. Completion was originally scheduled for 1962. The saucer-shaped antenna, 600 feet in diameter, will be more than twice as large as the antenna at Jodrell Bank, England, now the world's largest. Bigger radio telescopes are being built by scooping reflectors in the ground, such as the 1000-foot dish being built by the Defense Department in Puerto Rico. However, these cannot be rotated.

Construction at Sugar Grove began in September 1958. Recently the largest single piece of the structure was put in place in the center of the foundation—a 116-ton cylindrical piece of steel, 15 feet 4½ inches in height and 10 feet in diameter, which will serve as the shaft for the central pintle bearing.

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Agricultural research laboratory. A major U.S. Department of Agriculture research laboratory was dedicated on 31 October. Located 25 miles north of Columbus, Ohio, the new building will house the North-Central Forest Biology Laboratories, a unit of the Central States Forest Experiment Station, Forest Service; and the Shade Tree and Ornamental Plants Laboratory, a unit of the Agricultural Research Service.

* * *

Italian health institute anniversary. On 12 December the Istituto Superiore di Sanità of Rome will mark its 25th anniversary. A celebration will take place during the first International Symposium on National Health Institutes and Research in Medico-Sanitary Problems, which is being sponsored by the World Health Organization, the Italian Minister of Health, and the Istituto Superiore. For information, write to the Istituto Superiore di Sanità, Viale Regina Elena 299, Roma, Italy.

* * *

Teaching-improvement loans. The sum of $6,480,000 has been made available under Title III of the National Defense Education Act to provide loans for strengthening instruction in science, mathematics, and modern foreign languages in private nonprofit elementary and secondary schools. The Act requires that funds be allotted for use in the states and territories in proportion to pupil enrollment. All information on the loans program and application forms will be sent immediately, upon request, to schools that wish to file a loan request in this fiscal year. Address requests to: John R. Ludington, Director, Aid to State and Local Schools Branch, Office of Education, Washington 25, D.C.

* * *

Arctic sound named for Massey. An unnamed sound in Canada's arctic archipelago is to be named after Vincent Massey, former governor general of Canada. Massey Sound, as it will henceforth be known, is the feature between Axel Heiberg and Amund Ringnes islands in the Queen Elizabeth Islands of the northern archipelago. It is approximately 70 miles long and 30 miles wide. Massey has always been particularly interested in Canada's northland.

* * *

Molten salt reactor. The Atomic Energy Commission will build a reactor experiment of the molten salt type at the Oak Ridge National Laboratory as a part of the commission's effort to investigate advanced reactor concepts having potential advantages for the production of electrical power. The molten salt reactor concept offers the potential economic advantages of improved steam conditions and high efficiency through operation at very high temperatures and specific power. Since the fuel is in solution, no fabrication of fuel elements is necessary and continuous removal of fission poisons is possible.

Costs of the experiment are estimated at about $4,100,000, exclusive of research and development. Initial operation is planned for spring, 1963.

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Darwin film. The University of Chicago last month held a premiere showing of the "Darwin Centennial Celebration Documentary Movie," produced by Encyclopaedia Britannica Films, Inc. The new film is devoted to the celebration held at the university last November which attracted scientists from all parts of the United States and abroad, including Sir Charles Darwin and Sir Julian Huxley. The featured guest at the showing was John T. Scopes, a former University of Chicago graduate student and the school-teacher defendant in the famous Dayton, Tenn., "monkey trial" on the teaching of evolution.

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IAEA fusion journal. The first issue of *Nuclear Fusion*, a quarterly international scientific journal devoted to plasma physics and controlled thermonuclear research, was published last month by the International Atomic Energy Agency. Atomic fission, rather than fusion, has been the basis of most of the work done thus far in applying atomic energy for peaceful purposes. Continued utilization of the fission reaction depends primarily on the continued availability of uranium and thorium, the principal sources of fissionable material in nature. It is believed that these resources will ultimately have to be supplemented in order to satisfy the rapidly mounting energy demands of the peoples of the world.

Grants, Fellowships, and Awards

Biophysics. The National Academy of Sciences–National Research Council *ad hoc* Committee on International Relations in Biophysics has obtained funds to assist a number of U.S. biophysicists to attend the International Congress of Biophysics, Stockholm, 31 July–4 August 1961. A special committee has been established to screen applications for travel grants. Applications must be received no later than *31 December 1960*. Application forms may be obtained from the Committee on International Relations in Biophysics, Division of Biology and Agriculture, National Academy of Sciences–National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C.

Medicine overseas. The Association of American Medical Colleges is accepting applicants for a foreign fellowship program which gives future United States physicians opportunity to study medicine in remote areas of the world. The program, begun last year under the sponsorship of Smith Kline and French Laboratories, enables selected medical students of either sex who have finished either their third or fourth year of training to benefit from unusual clinical experiences and to practice preventive medicine at outpost facilities in greatly different societies and cultures. The foreign visits usually last about 12 weeks. Last year, grants totaling some $50,000 were made to 29 students from a $180,000 fund. It is expected that about 30 Fellows will be named in 1961. Applications, which are available through medical school deans, must be returned to the AAMC *by 31 December.*

NATO. At the request of the Department of State, the National Science Foundation will again administer United States participation in North Atlantic Treaty Organization fellowships in science. About 50 fellowships will be awarded citizens and nationals of the United States to encourage further study in the sciences abroad.

Awards will be made in the mathematical, physical, and engineering sciences; in medical and biological sciences, including anthropology and psychology (exclusive of clinical psychology); and in certain social sciences. Included, as well, are interdisciplinary fields which overlap two or more scientific disciplines. Applicants must, by the anticipated beginning of the fellowship, have earned a doctoral degree in one of the above-listed sciences or must have had research training and experience equivalent to that represented by the doctoral degree.

Applicants are encouraged to apply for study in a country that is a member of the NATO community; however, consideration will be given to those planning study elsewhere. NATO fellows will receive $4500 for tenures of a full year and $3375 for the academic year. Limited round-trip travel and dependency allowances will also be provided.

Applications will be evaluated for the National Science Foundation by panels of scientists appointed by the National Academy of Sciences–National Research Council. Detailed information may be obtained from the Fellowship Office, National Academy of Sciences–National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C. Completed application forms must be received by the NAS–NRC *by 19 December.* Awards will be announced on 3 April 1961.

National Science Foundation. The National Academy of Sciences–National Research Council has again been called upon to advise the National Science Foundation in the selection of candidates for the foundation's program of graduate and postdoctoral fellowships. The foundation plans to award approximately 1200 graduate and 150 postdoctoral fellowships in these two programs during the 1961–62 academic year. Academy–Research Council committees will evaluate the applications of all candidates. Final selection will be made by the foundation, and awards will be announced on 15 March 1961.

These fellowships, which are open to citizens of the United States, may be applied to advanced study in the mathematical, physical, medical, biological, and engineering sciences, including anthropology, psychology (exclusive of clinical psychology), and the following social sciences: geography, mathematical economics, econometrics, demography, information and communication theory, experimental and quantitative sociology, and the history and philosophy of science. They are open to college seniors, graduate and postdoctoral students, and others with equivalent training and experience.

All applicants for graduate (predoctoral) awards will be required to take the Graduate Record examination designed to test scientific aptitude and achievement. This examination, administered by the Educational Testing Service, will be given on 21 January 1961, at designated centers throughout the United States and in certain foreign countries.

The annual stipends for graduate fellows are as follows: $1800 for the first year; $2000 for the intermediate year; and $2200 for the terminal year. The annual stipend for postdoctoral fellows is $4500. Limited allowances for tuition, laboratory fees, and travel will also be provided.

Further information and application materials may be obtained from the Fellowship Office, National Academy of Sciences–National Research Council, 2101 Constitution Ave., NW, Washington 25, D.C. The deadline for receipt of applications for regular postdoctoral fellowships is *19 December 1960* and for graduate fellowships, *6 January 1961.*

Scientists in the News

Max Tishler, president of the Merck Sharp and Dohme Research Laboratories Division of Merck and Co., Inc., has been chosen to receive the 1961 Industrial Research Institute Medal, which is awarded annually for achievement in the management and organization of scientific research in industry. Tishler, who is a member of the National Academy of Sciences, heads the staff of more than 1000 that conducts Merck's $20-million-a-year research effort in widely divergent fields, ranging from human health and nutrition to electronics. He pioneered the introduction of cortisone and hydrocortisone, penicillin and streptomycin, B_{12} and other vitamins in the 1940's as head of Merck's development team. His many

Max Tishler

other scientific achievements include the first synthesis of hydrocortisone in 1950. The medal will be presented next May at the annual meeting of the institute.

Manuel Morales, career investigator of the American Heart Association and formerly professor and chairman of the department of biochemistry at Dartmouth Medical School, has been appointed professor of biochemistry at the University of California School of Medicine (San Francisco) and staff member of the Cardiovascular Research Institute.

Three others from Dartmouth, all associate professors of biochemistry, have joined the University of California and its Cardiovascular Research Institute—**Jen Yang, Shizuo Watanabe,** and **Jean Botts**. The first two have retained their titles, and the third is now associate professor of physiology.

Joe M. Smith, professor of chemical engineering and chairman of the department at Northwestern University, has been named winner of the 1960 William H. Walker Award of the American Institute of Chemical Engineers. The award, which is made "to encourage excellence in contributions to the chemical engineering literature," will be presented during the annual meeting of the institute at the Statler-Hilton Hotel, Washington, D.C., 4–7 December. Smith is the author of some 50 books and technical articles on the interaction of physical and chemical processes, heat transfer, thermodynamics (particularly thermodynamic properties of fluids), and applied chemical kinetics and reactor design.

Maurice Bender has been appointed chief of the research and training grants branch in the Division of Air Pollution of the U.S. Public Health Service, Washington, D.C. He was formerly executive secretary of the cancer chemotherapy study section of the Division of Research Grants at the National Institutes of Health, Bethesda, Md.

The Atomic Energy Commission has announced the appointment of **John V. Vinciguerra** as director of the Office of Contract Policy. He succeeds **John R. Moore**, who has been transferred to the commission's Oak Ridge Operations Office as assistant manager for administration. Vinciguerra was formerly assistant director for safeguards in the Division of International Affairs.

Milton U. Clauser, former vice-president and director of research for Ramo-Wooldridge's Space Technology Laboratories, has formed the Clauser Technology Corporation in Torrance, Calif., which will engage in the development and production of electronic equipment for missiles. After 13 years with Douglas Aircraft Company, Clauser became head of the School of Aeronautics at Purdue University. In 1954 he joined the Ramo-Wooldridge organization.

The new company's scientific staff includes George A. Bronson, chief engineer; Fred W. Schmidlin, solid-state physics; Donald J. Farmer, quantum electronics; and Lee O. Heflinger and Edward L. Garwin, magnetohydrodynamics and space simulation.

Evert Arne Bjerhammar, professor of geology at the Swedish Royal Institute of Technology, Stockholm, has begun a 2-month lecture tour of engineering colleges in the United States. The tour is sponsored by the Engineers Joint Council and the American Society of Civil Engineers under a grant from the National Science Foundation, and is coordinated by the Surveying and Mapping Division of the ASCE. Bjerhammar is a specialist in optical and electronic distance measuring devices, parallax-triangulation automatic mapping, and applications of the calculus of matrices to the method of least squares. His tour includes some 25 colleges and universities throughout the country.

N. R. Brewer, associate professor in the department of physiology and superintendent of animal quarters at the University of Chicago, has received the 1960 Griffin Award of the Animal Care Panel in recognition of his pioneering work in the field of laboratory animal care.

Merlin D. Peterson, formerly director of Industrial Reactor Laboratories, Inc., Plainsboro, N.J., has resigned that position to accept an appointment as deputy associate laboratory director for education at Argonne National Laboratory.

After 7 years as a project architect at the University of California Lawrence Radiation Laboratory in Berkeley and Livermore, **Philip W. Faulconer** has left on a year's tour of laboratories and research organizations in Japan, India, and Europe.

Microbiological Associates, Inc., Bethesda, Md., has announced the appointment of **George E. Jay, Jr.**, as director, department of laboratory animals. Previously he served as the genetics and animal resources officer for the Cancer Chemotherapy National Service Center of the National Cancer Institute.

George E. Pake, professor of physics at Stanford University, has received the alumni award of merit from Carnegie Institute of Technology. He is the originator of nuclear resonance techniques for analyzing the structure of crystals and is a member of the governing board of the American Institute of Physics.

Nathan E. Cohen, dean of the School of Applied Social Sciences at Western Reserve University, will deliver a principal address at the 10th International Conference of Social Work, to be held in Rome, 8–14 January.

Lars Lindquist of Uppsala University, Sweden, will spend this year as a National Academy of Sciences–National Research Council visiting scientist at the Quartermaster Research and Engineering Laboratories in Natick, Mass.

William L. Bradford, chairman of the department of pediatrics at the University of Rochester School of Medicine and Dentistry and a member of the faculty since 1926, has received the 1960 Gold Medal of the university's Medical Alumni Association. The award is given to a faculty member in recognition of integrity and inspiring teaching.

Harry L. Rietze, since 1958 assistant regional director in Alaska for the Bureau of Commercial Fisheries, U.S. Fish and Wildlife Service, has been appointed director. He replaces **John T. Gharrett**, who was recently transferred to Gloucester, Mass., as regional director for the bureau's North Atlantic Region.

Lawrence R. Boles, professor and head of the department of otolaryngology at the University of Minnesota, was named president-elect of the American Academy of Ophthalmology and Otolaryngology at the 65th annual business meeting, on 13 October in Chicago. He will take office in January 1962, succeeding **Dohrmann K. Pischel**, San Francisco, who is now president-elect and will become president in January 1961.

Robert W. Knecht, who has just returned from a year's study at Cavendish Laboratory, Cambridge, England, has been named assistant division chief of the Ionosphere Research and Propagation Division of the Boulder Laboratories of the National Bureau of Standards. This new assignment is in addition to his present duties as chief of the Sun-Earth Relationships Section of the Boulder Laboratories.

Jason J. Nassau, professor of astronomy and formerly director of the Warner and Swasey Observatory and the Nassau Astronomical Station of Case Institute of Technology, has been elected a corresponding member of the Academy of Athens in Greece. He is one of six such foreign corresponding members.

The Martin Company, Baltimore, has announced the appointment of **William S. Stringham**, for the past 7 years a nuclear chemist for the Goodyear Atomic Corporation, to supervise activities at Quehanna, Pa., where Martin has applied for a license from the Atomic Energy Commission to carry out advanced development work in isotopic power. Stringham will be in charge of laboratory facilities associated with five heavily shielded "hot cells" in which a variety of radioactive fuels for atomic generators can be handled.

Johannes van Overbeek, chief plant physiologist at Shell Development Company's Agricultural Research Laboratory in Modesto, Calif., has been awarded an honorary doctor's degree in agricultural science by the Institute Agronomique de l'Etat, Gembloux, Belgium. The presentation ceremony marked the institute's centennial celebration.

Robert Ornduff of the University of California, Berkeley, received the Cooley Award for the best paper presented at the annual meeting of the American Society of Plant Taxonomists. His paper was entitled "Hybridization between *Lasthenia* and *Crockeria* (Compositae): its taxonomic and evolutionary implications."

Thomas G. Ward, since 1956 professor of virology at the University of Notre Dame, has been named director, Division of Virus Research at Microbiological Associates, Inc., Bethesda, Md.

Melvin S. Day, formerly director, Office of Technical Information, U.S. Atomic Energy Commission, has been named deputy director of the National Aeronautics and Space Administration's Office of Technical Information and Educational Programs.

The training program for anesthesiology at the University of Washington School of Medicine (Seattle) was recently given departmental status and is to be headed by **John J. Bonica**, former director of anesthesiology at Tacoma General Hospital and Pierce County Hospital.

Also in the medical school, **J. Thomas Grayston**, has been appointed professor of public health and preventive medicine and executive officer of the department. An authority on infectious diseases, he has headed a U.S. Navy medical research unit in Taipei, Formosa, for the past 3 years. During that period he was on leave from a position as assistant professor of preventive medicine at the University of Chicago School of Medicine.

Recent Deaths

Johan G. Andersson, Stockholm, Sweden; 86; archeologist, who as a young man took part in several polar explorations, including Otto Nordenskoeld's Antarctic expedition of 1901–04; in 1909 was appointed head of the Swedish Geological Institute and later spent about 10 years as geological research adviser to the Chinese Government; honorary member of the Society of Antiquaries in London, the Royal Anthropological Institute of Great Britain, and the Ecole Française d'Extreme-Orient in Hanoi; 29 Oct.

John O. Bower, Philadelphia, Pa.; 75; former director of surgical research at Temple University Medical School who, with associates, developed a serum to combat acute appendicitis; in 1940 left Temple to establish the Foundation for Clinical and Surgical Research, which produced antiperitonitis serum and blood plasma during Wold War II; 30 Oct.

Leslie D. Cassidy, St. Louis, Mo.; 63; gastroenterologist and assistant professor of clinical medicine at the St. Louis University School of Medicine; was associate physician at the St. Mary's Group Hospitals for 19 years, and was on the executive committee at DePaul Hospital, where he had also served as chairman of the staff; 24 Oct.

Kenneth B. Clarke, Brooklyn, N.Y.; 59; superintendent of systems programming for the Defense Activities Division of the Western Electric Company; former coordinator of transportation and logistics for the Distant Early Warning Line, a network of radar warning stations in the Arctic constructed for the government by Western Electric; 28 Oct.

Peter L. Goldacre, Canberra, Australia; 34; a senior research officer in the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra; appointed in 1947 as one of the first two plant biochemists to join the plant division; in early research, largely enzymological, was the first to characterize the "indoleacetic acid oxidase" complex as being composed in part of a peroxidase, and was instrumental in discovering the activating effect of monophenols on this enzyme complex; later research emphasis was on the mechanism underlying differentiation of plant cells, which led to his discovery of "Kineapple," a yet uncharacterized, highly active cell division inducer from apple fruitlets; 16 Apr.

Harry H. Goode, Ann Arbor, Mich.; 51; professor of electrical engineering at the University of Michigan; known internationally for his work in the engineering of large-scale systems; served as a computer, mathematics, and defense consultant; a former technical director of the Bendix Systems Division, Ann Arbor; 30 Oct.

Alfred H. Lovell, Ann Arbor, Mich.; 76; professor emeritus of electrical engineering at the University of Michigan; joined the university faculty in 1911, became professor in 1919, was made head of the department in 1945, and retired in 1954; 27 Oct.

Robert B. McGraw, New York, N.Y.; 63; psychiatrist and a former clinical professor of psychiatry at the College of Physicians and Surgeons of Columbia University; served for 30 years, until 1958, as chief of the university's Vanderbilt Psychiatric Clinic; 23 Oct.

Robert S. Shaw, New York, N.Y.; 56; physicist on the faculty of the College of the City of New York since 1929; 24 Oct.

John C. Walker, Westfield, N.J.; 66; retired research director for the Cities Service Company, New York; an inventor who held patents in this country and abroad on corrosion control in gas and petroleum pipelines and on other processes; 31 Oct.

Book Reviews

Oasis and Casbah: Algerian Culture and Personality in Change. Anthropological Papers, Museum of Anthropology, University of Michigan, No. 15. Horace M. Miner and George De Vos. University of Michigan, Ann Arbor, 1960. vi + 236 pp. $2.50.

This book is an important landmark, for it is the first modern personality study of a Saharan community yet published. It deals with the sedentary Arabic-speakers of Sidi Khaled (a small oasis in the northwestern desert), including those who have remained and others who have become economic refugees in Algiers.

An excellent historical sketch and a detailed anthropological study by Miner are followed by a searching analysis of personality made by De Vos in consultation with Miner. The analysis is based mainly on Rorschach protocols of a random sample of 64 adult males.

Two main objectives were to test Kardiner's theory that institutions can be predicted from knowledge of basic personality and to discover at about what age personality really becomes set. "Blind" Rorschach analysis proved valid for cross-cultural personality rating, even with the intervention of interpreters, but inadequate for predicting relationships between psychological and cultural variables.

Compared with "normal" Americans, the total sample shows high levels of rigidity and maladjustment, which are correlated in the urban group but not in the oasis. Thought processes tend to be stereotypic and illogical as opposed to systematic, and a strong "obsessive-compulsive" quality is apparent; associative blocking is relatively high; and personality in general is "inner-directed" and individualistic. Anxiety and tension, and awareness of them, are higher in Sidi Khaled than in America, and higher in Algiers than in the oasis. Women are passive, "sexual objects" rather than "social beings"; yet they seem more "easy-going" and better adjusted to their lot than men. During childhood "There is little room for logical discussion, and recourse to objective fact is not often used as a way of settling issues." A man does not take for granted the loyalty or integrity of either his wife or his children. In short, Saharan Arabs are less matter-of-fact rationally than we are, even after intense urban exposure to Western thought and ways: they just don't think as we do.

I have had many years of both professional and casually social relations with the kind of people Miner and De Vos describe, and I agree wholeheartedly with their interpretations. But, in addition, I am inclined to draw from their material further conclusions which probably occurred to them but which are not stated specifically in their book. Chiefly, I seem to see in the personality of the Arab undergoing acculturation in Algeria a phenomenon which is painfully apparent elsewhere: an emotional compulsion to adopt the superficial culture traits (clothing, eating habits, public comportment, and so forth) of alien rulers, while at the same time intensifying those occult native culture concepts and systems of perception which are most antagonistic to the culture of the dominant alien community. Miner's case history No. 26 is particularly revealing in this respect, for here we see a typical intellectual "grass-roots nationalist" stripped to his naked soul.

To sum up, *Oasis and Casbah* is an enormously important book, even though it is too technical to be entertaining reading for any except specialists. Its importance lies in the fact that it is a searching "soil analysis," so to speak, of the ground in which the Algerian rebellion has its roots. Anyone interested in the march of events in North Africa today should read it without delay, as should anyone interested in the much broader problem of why Western governments so often fail to "make friends and influence people."

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The Future of Man. The BBC Reith Lectures, 1959. P. B. Medawar. Basic Books, New York, 1960, 128 pp. $3.

There was a time when the conflict between the hereditarians and the environmentalists seemed almost irreconcilable; the low point of this era was, perhaps, about 1897 when the sociologist C. H. Cooley published his essay "Genius, fame and the comparison of races."

Since that time we have progressed, for protagonists on both sides of the fence have found merit in the criticisms of the opposition and have corrected and enlarged their views. In recent years there have been several books that have gone a long way toward bringing together the conflicting lines of evidence. Among the best of these is this little book of Medawar's. With a fine eclecticism he describes a great variety of facts, in writing which is concise and clear but which is yet part of an overall structure that is surprisingly complex for so small a book. Why the complexity? I will return to this question after first describing the contents.

While making the greatest use of genetic knowledge, the author strongly enveighs against *geneticism*, which he defines (page 61) as "the application to human affairs . . . of a genetic knowledge or understanding which is assumed to be very much greater than it really is." Some of the errors that geneticism (or perhaps better, *biologism*) leads to he identifies as follows (page 99): "That competition between one man and another is a necessary part of the texture of society; that societies are organisms which grow and must inevitably die; that division of labour within a society is akin to what we can see in colonies of insects; that the laws of genetics have an overriding authority; that social evolution has a direction forcibly imposed upon it by agencies beyond man's control—all these are biological judgments; but, I do assure you, bad judgments based upon a bad biology." Similarly (page 34), the labeling of a family stock as degenerate because it has produced an unfortunate double recessive phenotype is bad biology. "People who brandish naturalistic principles at us," says Medawar (page 103) "are usually up to mischief. Think only of what we have suffered from a belief in the existence and overriding authority of a fighting instinct; from the doctrines of racial superiority and the metaphysics of blood and soil; from the belief that warfare between men or classes of men or na-

tions represents a fulfillment of historical laws. These are all excuses of one kind or another, and pretty thin excuses."

Such an argument from consequences might lead the unwary to suppose that the author would be on the environmental side of every argument; but this is not so. To begin with, he says (page 58) "It is extremely difficult to think of any social habit or act of legislation that has *no* genetic consequences. Penal, fiscal, social, moral, medical, political, or educational laws, schemes, treatments, habits or observances will all make *some* mark on our genetic structure." Medawar gives many illustrations of this fundamental axiom of eugenics. Building on the argument presented in the first two chapters of his earlier book, *The Uniqueness of the Individual* (Methuen, 1957; Basic Books, 1958), he points out that the continued development of the present tendency toward early completion of families will ultimately bring about the earlier appearance of the hereditary pathologies of the latter half of life—Huntinton's chorea, some manic depressive psychoses, and some kinds of cancer. Good intentions alone cannot save us from the unwanted consequences of our acts.

The treatment of the inheritance of intelligence is thorough and courageous. "Some people speak with angry contempt of 'so-called intelligence tests'; having satisfied themselves of the absurdity of claims which psychologists no longer make for them (and which the better psychologists never did make), they dismiss the entire subject from their minds. Others profess to attach no meaning to the word 'intelligence'—but try calling them *un*intelligent and see how they react. At the risk of being peremptory . . . I shall take the view that intelligence tests measure intellectual aptitudes which are important, though very far from all-important; and that these aptitudes make up a significant fraction of what we all of us call 'intelligence' in everyday life" (pages 74–75). He discusses in detail the meaning of the extensive surveys of Scottish children made in 1932 and 1947, which showed a slight increase in 'intelligence' for boys and a considerable one for girls. Antieugenicists have cited these results as a refutation of genetic fears. Medawar points to two environmental factors that could easily account for the apparent rise. First, there was an even greater increase in the physical development of the 11-year olds surveyed at the later period; since "mental" and "physical" are not really independent variables, this fact indicates that the chronological 11-year olds tested in 1947 were biologically older than the same nominal age group in 1932. Second, since our intelligence tests lean heavily on verbal ability the children tested in 1947, by virtue of radio and television, were more experienced in verbal techniques than the children of the preceding generation.

As I mentioned earlier, Medawar's book is remarkable in combining exceptionally clear exposition on a fine scale with an over-all complex structure. I would like to try to explain the reasons for the complexity, proceeding from relatively certain points to the relatively more controversial. First, we should note that these essays were originally given as lectures on the BBC. In spite of their difficulty (it would be inconceivable that an American broadcasting company would initiate such a series), they have a certain loose-jointed conversational way of "beating around the bush." This is certainly good for a lecture, and not bad for a book.

Second, in preparing the lectures for publication Medawar understandably felt obliged to add notes—documenting, justifying, and qualifying his spoken words. The result is a volume in which 19 percent of the content is in the form of notes. For the usual economic reasons the notes are not literally *footnotes* —that is, notes at the foot of the page— but are rather "tailnotes"—that is, notes placed at the end of the book. The argument is thus dispersed by the bibliographic machinery. The serious reader will find [as W. E. K. Middleton remarked in *Isis* **51**, 338 (1960)] that reading such a book "involves two bookmarks and about fourteen fingers, nineteen if he decides to make an index card of the reference."

The third (and most controversial) reason for the complexity is related to the "sensitiveness" of the topics discussed—eugenics, intelligence, value-bound individual differences, racial differences, and freedom in a population-harassed world. Whatever may be the best answers to the questions, we can assume a priori that these answers threaten every traditional political position, "conservative," "liberal," or what have you. A scholar, like all men, is a social animal, and he cannot entirely avoid being "other-directed," to use Riesman's phrase. As a result, when the scholar presents the heresies implied by new knowledge, his exposition may sometimes border on the ambivalent. (In the present instance, see Medawar's remarks on race, pages 60–63.)

To say *The Future of Man* is complex is not to damn it. It is one of the powers of an artist that he turns the necessities of time and medium to good use, and Medawar is a real artist with words, in the great English traditions of the Huxleys and Haldane. Like them, he shows by example that a love of scientific precision and a strong aesthetic sense are not mutually exclusive.

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Theory of Elementary Particles. Paul Roman. North-Holland, Amsterdam; Interscience, New York, 1960. xii + 575 pp. Illus. $12.

An examination of any volume of *Physics Abstracts* would indicate that the theory of elementary particles is one of the major subjects of investigation in contemporary physics. In spite of this, there is an absence of useful textbooks in the field, with the result that the beginning student must study the original literature, often without a reliable guide to the relevant papers. Roman's book is an attempt to provide such students with an introduction to the main theoretical principles which are used in elementary particle physics, with particular emphasis on the symmetry properties of the interactions of particles. Regrettably, his book is only partly successful in fulfilling this aim.

The most valuable parts of the book are the first two chapters, which present the elements of group theory, the representations of the four-dimensional orthogonal group, and the algebraic aspects of the Dirac, Klein-Gordan, and Fierz-Pauli equations. The discussion here is clear and the writing style interesting.

In the next section of the book, the symmetries of space reflection, time reversal, and charge conjugation are discussed, and the implications of recent theoretical and experimental work on weak interactions are presented. The presentation here, while on the whole useful, is marred by several misstatements, and any student reading the book must exercise care. For example, this chapter includes a "proof" of the false theorem that if charge conjugation invariance holds, the effect of parity nonconservation cannot be detected if the final state is weakly interacting.

The final chapter deals with isotopic spin and its generalizations. It is in the theory of strong interactions that present-day elementary particle theory is faced with its greatest problems; hence, it is here that a textbook is hardest to write. The author has chosen to present many highly speculative ideas, some of which have already been made obsolete by newer developments, without making clear that the evidence for them is somewhat weaker than for Lorentz invariance, for instance. The inclusion of such material in a textbook is probably unwise. It will perhaps be impossible to write a really adequate text on the theory of elementary particles until more of the major problems of that theory have been solved.

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Atlantic Hurricanes. Gordon E. Dunn and Banner I. Miller. Louisiana State University Press, Baton Rouge, La., 1960. xx + 326 pp. Illus. $10.

The large, rotary, tropical storm known regionally as the "hurricane," "typhoon," or "tropical cyclone" has a capacity for death and destruction well known to coastal and island inhabitants of the United States, Mexico and other Central American countries, Japan, China, the Philippines, and the South Pacific and Indian oceans. As many as 300,000 people have perished in a single storm, and two storms in the United States—Diane (1955) and Donna (1960) —have each caused damage that amounted to nearly $1 billion. Their energy output borders on the fantastic: the conversion of one day's hurricane winds would supply the electrical power requirements of the United States for six months. An average hurricane produces 20 billion tons of fresh water a day, which someday may be used by thirsty and ingenious future generations.

This book, written by two members of the Weather Bureau's hurricane forecast center at Miami, Fla., contains background information and safety features which could well mean the difference between life and death for large numbers of Americans who, in recent years, have moved to ocean beaches or who have ventured forth in boats into areas vulnerable to hurricanes. Much recent progress has been made in hurricane detection, tracking, and prediction by use of weather reconnaissance aircraft, radar, hurricane "beacons," and statistical and dynamical techniques involving use of electronic computers. These developments, combined with more effective dissemination of warnings, have brought the ratio of fatalities to property damage down by a factor of 60 in the past 30 years.

A glimpse into the potential contribution of weather satellites is given by a picture of the pinwheel clouds of a tropical cyclone observed near New Zealand on 10 April 1960 by the first weather satellite, Tiros I.

The book is given sharp focus by several fascinating eyewitness accounts made by survivors, some of them professional meteorologists, of outstandingly destructive hurricanes. A brief account of normal tropical weather patterns is followed by discussion of hurricane climatology, characteristics, energy, theories of forecasting, and destructive storm tides, surges, waves, rain floods, and winds. Sections of considerable practical value are devoted to the hurricane warning system, how to prepare for hurricanes, ways to improve zoning laws and building codes, and how to survive when the storm hits. The appendixes contain a listing of hurricanes that afflicted the United States from 1653 to 1958 and a useful glossary of meteorological terms.

Of particular interest are the sections devoted to the results of recent hurricane research, particularly those stemming from the extensive field activities of the National Hurricane Research Project; this project, the largest ever devoted to the study of a single meteorological phenomenon, owes its establishment to the increased federal support which was provided after the disastrous hurricanes of 1954 and 1955. In answer to the inevitable question of hurricane control, there is a brief account of several inconclusive hurricane seeding experiments as well as an account of the formidable problems involved in counteracting such energetic atmospheric phenomena.

For the more scientifically minded, the book will not serve as an adequate substitute for the chapter on tropical storms contained in Riehl's *Tropical Meteorology* (1954) or for the section on climatology and the record of storm movement and behavior found in Tannehill's *Hurricanes* (1944). Perhaps the book's greatest shortcoming is its failure to put in specific terms the principal unresolved problems concerning hurricane structure, behavior, and movement or to show how progress in the solution of these problems could contribute to improved understanding and prediction. By and large, however, the book provides interesting reading for the layman and vital information to state and city officials, construction engineers, and others concerned with alleviating hurricane damage.

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The Search for Order. Cecil J. Schneer. The development of the major ideas in the physical sciences from the earliest times to the present. Harper, New York, 1960. xvii + 398 pp. Illus. $6.

This is one of many recent books designed to introduce science to the general reader. More than most, it succeeds in portraying science as an essential part of our cultural heritage and as a framework for modern ideas and beliefs.

Necessarily the author limits himself to a few topics, to "scientific ideas which in my opinion have had the greatest influence on the evolution of civilization." These ideas progress from the cosmology of the solar system to mechanics, thermodynamics, evolution, field theory, relativity, and quantum theory. Chemistry and geology are limited to brief chapters, biology appears only in the discussion of evolution, and stellar astronomy is hardly mentioned. No two scientists would agree completely about the wisdom of this distribution, but certainly the topics selected provide material for a coherent, colorful, many-faceted, and often exciting story. The story is told with great zest, good humor, and broad understanding. Scientific ideas are set against a background of history and philosophy which serves admirably to bring out their relevance to the development of Western civilization. The author should be commended especially for his vivid and unorthodox biographical sketches of eminent scientists—sketches accompanied by numerous apt quotations from their writings.

The major shortcoming of the book is the brevity of its treatment of the scientific ideas themselves. There is no escape from this, of course, if the historical and philosophical material is to be retained and if the book is to be held to a reasonable length. The relation of force to acceleration, the con-

cept of atomic weight, the second law of thermodynamics, the interpretation of spectra, the uncertainty principle—all traditional stumbling blocks to novices in science—are presented rapidly, nonchalantly, with practically no examples and few diagrams. The extreme condensation in places leads to statements which a nonscientist would find misleading or confusing—for example, the assertion that alkali metals "combine with oxygen in the proportion 2:1" (page 149); the picture of a molecular model with no caption other than "Structural chemistry" (page 152); the use of ocean waves as an example of simple transverse wave motion (page 246); the casual statement about "certain sharply defined frequencies . . . called line spectra" (page 349). More serious, perhaps, is the impression left by some of the brief discussions that scientists are a species of wizard, who effortlessly hit on the magical equation or the kind of experiment necessary to solve a problem.

This characteristic of the book may be a shortcoming or not, depending on the audience for which the book is intended. A reader with a modest background in elementary science could fill the gaps and resolve the ambiguities without trouble. Henry Margenau, in a foreword, expresses "a strong desire to see this sort of treatment in the hands of my physics and of my philosophy students"; and for such students, the book is admirably suited. On the other hand, the author himself maintains that "the objective of the book is to introduce the physical sciences," presumably to liberal art students like those in his own classes. It seems questionable just how clear a conception of science such students will obtain from discussions that gloss over difficulties and apparently require no rigorous thinking on the part of the reader. The scarcity of numerical examples and diagrams, the lack of end-of-chapter questions, the near-absence of subheads in the text, the masking of important definitions by philosophical asides—these hardly seem calculated to help beginners in learning science.

One other aspect of the book makes it ill-suited for elementary classes. At times the author is lured by his philosophical rambling into assertions which by themselves sound pretty extreme. One example, at the end of a discussion on entropy, probability, and determinism, is this bald statement: "We have recovered free will." Another, apropos "the white-coated multitude" of applied scientists, is the statement: "These men are the most dangerous of all. They are the illusion but not the stuff of which civilization is made." Now both of these examples are here taken out of context, and both are reasonable enough in the paragraphs where they occur. But elementary students have a genius for taking statements out of context; these examples are the sort of thing that students like to underline in red pencil, and remember long after they have forgotten the rest of the text.

Objections of this sort are, of course, only facets of the much-debated and never-solved question of how science can best be presented to liberal arts students. In defense of a book like this one, it can be argued that a student on reading it will find science palatable, he will get at least an emotional appreciation of the contributions of science to our culture, he will learn enough of the vocabulary to sound sophisticated, and he should be impressed with the provisional, empirical nature of scientific hypotheses. Perhaps this is all that can be expected. For teachers who feel that students need more personal contact with the rigors of scientific thinking, however, the book can serve only as a supplement to a more orthodox presentation.

As supplementary reading in an elementary course, or as a text for more advanced students with a sound background in science, philosophy, and history, the book is a valuable contribution to the increasing body of literature that attempts to bridge the gap between the "Two Cultures" of C. P. Snow, the scientific and humanistic cultures of the modern world.

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Miscellaneous Publications

(Inquiries concerning these publications should be addressed not to Science, *but to the publisher or agency sponsoring the publication.)*

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Reports

Radiation Flavor—Fact or Fancy

Abstract. Experimental results indicate that sensory evaluations in different laboratories give equivalent results if standardized procedures and a standard sample are used. Conflicting results concerning the flavor of irradiated foods are due largely to different methods of evaluation and to incorrect interpretation of results. Unusual flavor due to irradiation should be considered different, not necessarily objectionable.

It is estimated that the sterilization of food by ionizing radiation at a dose of 4.5 megarad breaks about 0.0075 percent of the chemical bonds (*1*). That this small absolute change is quite apparent to man's olfactory and gustatory senses, which have a sensitivity of parts per billion, has been amply documented in the literature. Unfortunately, a critical appraisal of the literature also indicates that various laboratories have frequently disagreed as to the extent and importance of the sensory changes produced. As a result, objective evaluation of the potential of ionizing radiation to preserve foods has been difficult for scientists and nonscientists alike.

An attempt to resolve some of the diversity of research results in this field occurred in 1957 when investigators in the Quartermaster Corps Radiation Preservation of Foods Project formulated a controlled, cooperative experiment in which a standard homogeneous sample of meat was used. It had been suggested that the diversity of results might be due to the difference in the experimental materials used, to unrecognized variations in treatment and testing procedures, or to nonuniformity in the interpretation of results. It was hoped that through a controlled experiment with a standard sample of meat, the data and results reported by different investigators could be compared and correlated, and some explanation could be obtained for the nonagreement of earlier data.

Such a study was subsequently carried out with 17 cooperating investigators. Unfortunately, the results did not give the hoped-for correlations between flavor and chemical evaluations. This was partly because of technological difficulties in preparing, handling, and shipping the meat, and partly because of an obviously great variation in laboratory procedures and expressions of results. The success of this first study lay primarily in its focusing of attention on the problems involved in designing and executing such an experiment.

Plans for a second cooperative study were formulated in early 1958. In this study it was decided to concentrate upon sensory evaluation, since it was felt that the greatest amount of variability in methods and interpretations arose in that area. Moreover, it was obvious that until reliable sensory evaluation could be achieved, a correlation of chemical evaluation with flavor would not be possible.

Accordingly, a test plan was formulated which attempted to standardize, in so far as possible, the methods of preparation and evaluation, so that any differences found would be attributable to factors other than methods (*2*). Two sensory testing methods were used. One required rating of the intensity of "irradiation flavor"; the other was the hedonic-scale preference method (*3*). The chief difference in the methods was the use of "experts" for rating intensity of irradiation flavor and "consumer-type" subjects in the preference tests.

The average intensity and hedonic-scale ratings are shown in Table 1. The intensity of irradiation flavor is shown to be a direct (though not linear) function of dose. The agreement among laboratories for this method is excellent, the mean correlation coefficient r (by Fisher's z method) being 0.94.

In the preference tests, no differences were found between the nonirradiated samples and the samples irradiated with 1.25 and 2.5 megarad, respectively, and only the sample irradiated with 5 megarad was significantly less preferred ($.01 > p > .001$). While the mean correlation coefficient r for this method was only 0.55, the absence of a definite trend among the four samples gives some clue to the reason for the low correlations.

The results clearly indicate that the purpose of the test had been accomplished—that is, it had been demonstrated that sensory evaluations carried out by a number of different laboratories give equivalent results if standardized procedures and a standard material are used.

The results also suggest that the nonagreement of research results reported in the literature is due, to a large degree, to differences in interpretation of the results. The value of a panel of experts lies in the ability of its members to evaluate a particular component of the total flavor according to the instructions given, but no correlation of this evaluation with a preference rating of the sample should be assumed.

Although an evaluation of the relationship of irradiation flavor and preference was not an objective of the cooperative study, the results suggested that investigations of such a relationship were in order. It must be assumed that the preference-test subjects could detect the irradiation flavor, even though their preferences were not affected by it except at the highest level of irradiation.

Table 1. Data on cooperative flavor evaluation of a standard beef sample (*2*). Method *A*, intensity of irradiation flavor (1–none to 9–extreme), at eight laboratories; method *B*, hedonic-scale preference tests, at ten laboratories; *r*, mean correlation coefficient. The slope over the four ratings under method *A* is highly significant ($p > .001$).

Irradiation levels (Mrad)	Av. rating	
	Method A (r = 0.94)	Method B (r = 0.55)
0	2.1	6.1
1.25	3.7	6.0
2.5	4.5	6.0
5	5.2	5.4*

* Significantly different from the other three values ($.01 > p > .001$).

Table 2. Mean preference ratings of irradiated beef samples by the same individuals at successive intervals.

Day	Judgments (No.)	Av. ratings (hedonic scale)	
		(0 Mrad)	(4 Mrad)
1	80	7.3	6.3*
2	68	7.5	6.2*
3	74	7.4	6.3*
4	72	7.3	6.1*
16†	54	7.3	6.5
23†	60	6.8	6.4

* Significantly less preferred ($p > 0.001$). † Data not tested for significance.

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

The question then arises as to whether a consumer will learn to recognize, and to like or dislike, the flavor upon further or repeated consumption of irradiated beef products. To test this potential of recognition, a panel of 40 consumer-type subjects was requested to rate non-irradiated and irradiated ground beef on 4 successive days and again on the 16th and the 23rd days from the start of the test. In each test session each subject rated two nonirradiated samples and two samples irradiated at a level of 4.0 megarad; all samples were identified only as "ground beef."

The mean preference ratings obtained are shown in Table 2; for statistical analyses, only the data from the 28 subjects who participated on each of the first 4 days were included. Again, a high level of irradiation is shown to decrease consumer preference to a significant extent. There was no significant difference between the ratings given either the nonirradiated or the irradiated samples on any single day, however, and no change was evident in people's preferences in regard to irradiated beef with repeated exposure to the product. Although too few subjects ($N = 18$) participated in all of the sessions for an analysis of variance for the 16th and 23rd days to be conclusive, the data suggest that there was less difference in the preferences between nonirradiated and irradiated samples at the end of the test than at the beginning.

The results in the experiments discussed here suggest that the view that irradiated foods have objectionable flavors is not wholly justified. It seems probable that an attitude of suspicion toward anything connected with irradiation, coupled with the noticeable change in flavor, accounts for the opinion. An analogous evaluation situation would be the attempt to obtain a meaningful flavor evaluation for a canned orange juice with a panel of judges who traditionally drink fresh orange juice and interpretation of their evaluations by the staff of a manufacturer of frozen orange juice.

While it is true that the responses of a representative tasting panel may foretell the influence of attitude upon consumer acceptance, it should be remembered that attitudes change and that it will be several years before irradiated foods are offered to the public. It seems more meaningful at this time, therefore, to recognize that irradiation produces changes in flavor but that such changes are not necessarily objectionable (*4*).

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4. The assistance of participating scientists and laboratories in carrying out the cooperative study is gratefully acknowledged. This report is paper No. 2054 in a series approved for publication. The views and conclusions are ours.

4 June 1960

Control of Behavior by Presentation of an Imprinted Stimulus

Abstract. When presentation of an imprinted stimulus is contingent upon an arbitrarily chosen response, the rate of emission of this response increases. This control of responding requires a moving imprinted stimulus and does not require a following response by the duck.

Imprinting has been described as "the process by which certain stimuli become capable of eliciting certain 'innate' behavior patterns [during] a critical period of the animal's behavioral development" (*1*). In particular, ducklings have been observed to follow moving objects and to develop a lifelong affinity for the followed object. The experiments reported here (*2*) demonstrate that control of the duckling's behavior by the presentation of the imprinted stimulus is not limited to the elicitation of innate responses. The presentation of the imprinted stimulus will also control the rate of emission of an arbitrarily chosen response.

The experimental space was a rectangular, black plywood box divided by a Plexiglas panel into a runway that contained the duck and an apparatus compartment that contained the imprinting stimulus, a yellow cylinder (Fig. 1). "Presentation" of the stimulus consisted of transilluminating it and lighting the dark apparatus compartment. The imprinting stimulus was moved continuously back and forth along the runway, with a slight swaying and twisting motion, at 1 ft/sec. The response chosen for study was a peck of 8 gm or more on a Plexiglas disk 0.75 in. in diameter. This manipulandum (response key) was mounted on the wall of the runway opposite the dividing panel, at a suitable height (3 to 8 in.). White noise and dim illumination were always present in the runway; neither food nor water was ever present.

Two species of duck, Black (*Anas rubripes tristis*) and Peking (*A. platyrhynchous*), were employed in sessions lasting from 1 to 12 hours; similar results were obtained with the two species. The ducks were housed in individual cages a few hours after hatching and were given continuous access to food and water. Each duck was placed in the runway, and the imprinting stimulus was presented for six 45-minute periods distributed throughout the duck's first and second days of life. All of the ducks were observed to follow the moving stimulus closely by the end of the second day.

When the presentation of the imprinted stimulus is contingent on a selected response, the rate of emission of this response increases. Figure 2 shows the sustained rate of pecking by a 3-day-old duck when the imprinted stimulus was presented for 40 seconds after every eighth response. No appreciable decline in the rate of responding after 12 hours of conditioning and 750 reinforcements is observed (the reduction in the rate of responding in the portion of the record marked *a* was correlated with a temporary equipment failure: the imprinted stimulus did not move when presented).

The performance shown in Fig. 2 was obtained with the following procedure: After the final imprinting session, the peck response was conditioned by making presentation of the imprinted stimulus contingent upon responses that increasingly approximated pecking. The response requirement was then gradually increased over a 75-minute period until every eighth response produced the imprinted stimulus. The imprinted stimulus may properly be called a reinforcer (*3*, p. 731) since it increases the rate of a response which produces it. However, the imprinted stimulus differs from other reinforcers, such as food and water, in its control of pecking in that the rate of responding was not observed to decline after a large number of reinforcements.

The rate of emission of responses that produce the imprinted stimulus was brought under the control of a

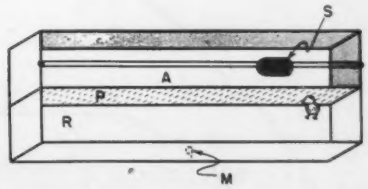

Fig. 1. Experimental space for the control of responding by means of an imprinted stimulus. A plywood box is divided by a Plexiglas panel (*P*) into a runway (*R*) (8 by 1.5 by 1.5 ft) and an apparatus compartment (*A*) (8 by 1 by 1.5 ft). The imprinting stimulus (*S*) is a transilluminated yellow cylinder (4 by 8 in.). The manipulandum (*M*) is a 0.75-in. Plexiglas disk.

discriminative stimulus. Under one condition the response key was transilluminated and reinforcement was contingent upon the completion of ten pecks. Under a second condition the key was darkened and reinforcement was contingent on at least 1 minute of no response. These conditions were alternated, and each condition was terminated by a reinforcement. After 4 hours of training on this multiple schedule of reinforcement (*3*, p. 729) the duck responded during presentation of the stimulus that accompanied reinforcement for responding and did not respond during the presentation of the stimulus that accompanied reinforcement for not responding.

A response was conditioned that was incompatible with the response of following the imprinted stimulus. A transparent key that enabled the duck to see the imprinted stimulus while responding was mounted midway along the Plexiglas wall. The imprinted stimulus was presented for 1 second after each response. Although this brief presentation was too short to permit the following response, a high rate of pecking was sustained. This finding suggests that the following response is not necessary for presentation of the imprinted stimulus to function as a reinforcer.

To show that the pecking response was not maintained solely by the change in illumination concurrent with presentation of the imprinted stimulus, an attempt was made to sustain responding when the reinforcement consisted only of a change in illumination. First, a stable rate of pecking was obtained by presenting the imprinted stimulus after every tenth response (Fig. 3). At point *a*, the moving stimulus was removed from the apparatus compartment and only the change in illumination was contingent upon responding. The rate of responding declined rapidly, and no responses were emitted for several sessions. At point *b* the schedule of reinforcement was adjusted so that each response, rather than every tenth response, produced the change in illumination. The lights in the apparatus compartment were then turned on for 1 minute. Figure 3 shows that this operation did not initiate responding. The moving stimulus was replaced in the box and, at point *c*, the lights in the apparatus compartment were again turned on for 1 minute. After the reintroduction of the imprinted stimulus, the duck began to peck. The rate of responding continued to rise during the next hour.

The reinforcer in these experiments comprised a complex of events including a change in illumination, presentation of the moving stimulus, and following by the duck. The findings reported above suggest that following is not a necessary component of the reinforcement but that the imprinted stimulus is.

Another experiment showed that the imprinted stimulus must be moving in order to control the rate of responding. A stable rate of pecking was obtained by presenting the imprinted stimulus after every tenth response. When the apparatus was adjusted so that the imprinted stimulus no longer moved during presentation, the rate of responding fell rapidly to zero. The pecking response was obtained again on the following day by reintroduction of the moving stimulus.

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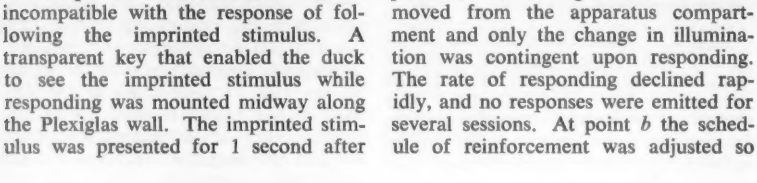

Fig. 2. Rate of pecking by a 3-day-old duck. Each diagonal mark represents a 40-second presentation of the imprinted stimulus after every eighth response (time was not recorded on the abscissa during the presentation of the stimulus). The duck received 750 reinforcements in 12 hours.

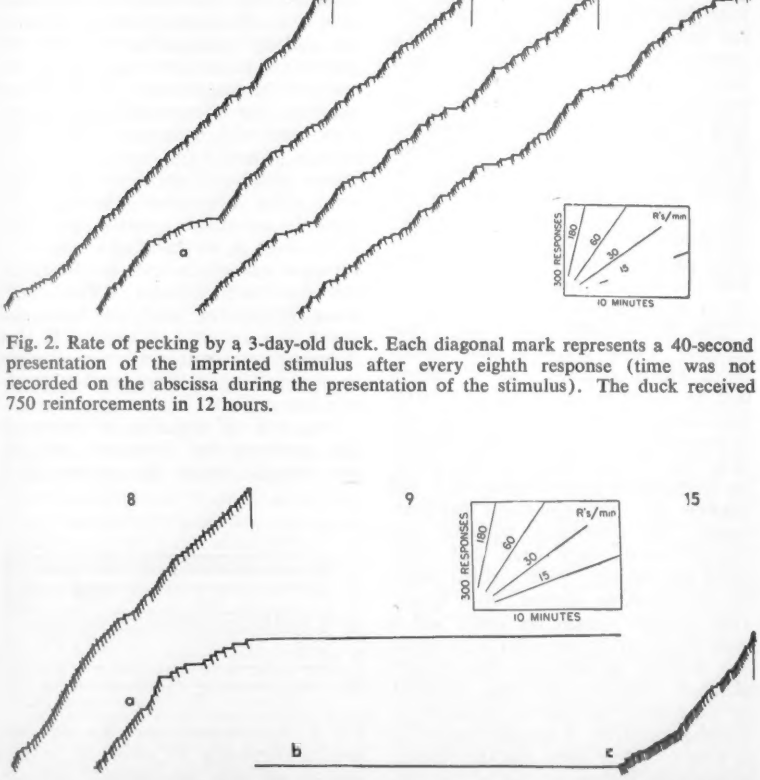

Fig. 3. Records of pecking by a 3-day-old duck. The first record (session 8) shows the rate of responding when the imprinted stimulus was presented after every tenth response. In session 9 the moving stimulus was removed at *a*, and every eighth response produced only a change in illumination. In session 15 illumination was contingent on each response; at *b* the apparatus compartment was lit for 1 minute. At *c* the imprinted stimulus was presented for 1 minute, and reinforcement was then contingent on each response.

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14 June 1960

Color Phenomena

Abstract. A procedure is described which leads to reports of hues for two black figures, one of which is shadowed. Typically, the shadowed figure is seen as blue, the other as black.

If two properly spaced circles drawn in India ink on a white card are placed in a stereoscope so that on fusion two concentric circles are seen, then the circle presented to a red-filtered eye typically appears blue or blue-green and the circle presented to the nonfiltered eye typically appears dark red (*1*). While I was looking through the stereoscope, with the red filter accidentally removed, it appeared to me that one circle was blue and the other green.

The relative imbalance of the amount of light to the two sides of the card appeared to be the critical variable.

In order to investigate this variable further, an index-card partition was affixed perpendicularly at the midpoint of the line joining the centers of the two circles. In an otherwise dimly illuminated room, the light from a 100-watt bulb in a gooseneck lamp was directed to one side of the card, the partition casting a shadow on the other side. No red filter was in the instrument.

With individual regulation of the distance of the bulb from the card, 16 or 35 subjects reported a blue circle on the shadowed side and a black circle on the bright side, 5 reported purple on the shadowed side and black on the bright side, 3 reported blue on the shadowed side and gray-green on the bright side and, finally, only 4 reported both circles as black. The remaining 7 of the 35 subjects reported other hue combinations for the two circles. The blueness disappeared immediately for some subjects, gradually for others, when the shadowed circle was viewed monocularly. The hue returned immediately with binocular inspection. The results were not affected either by changing the position of the bulb so that the formerly bright side was now shadowed, by initial monocular inspection followed by binocular inspection, or when neutral filters of unlike densities were used to produce one-sided lighting.

It is possible that the yellowish incandescent light was the responsible factor since blue is complementary to yellow. However, the gray-green reported on the bright side by a few subjects offers some difficulty to such an interpretation since this circle is also in yellowish light. Nevertheless, viewing the circles in different illumination may be of value. In white fluorescent light 5 or 12 additional subjects reported blue for the circle on the shadowed side and black for the circle on the bright side, 1 subject reported blue for the shadowed circle and green-gray for the other, and 6 reported black for both circles. For 7 other subjects in daylight, 3 reported the typical blue-black combination, 3 a black-green combination, and one black only. Continuation of this line of experimentation seems desirable because it might provide evidence for an interocular color effect (*2*).

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2. I wish to thank Professor B. Hoffmann of the Department of Mathematics of Queens College, who served as a subject, for his stimulating comments on the procedure and the results.

27 July 1960

Discovery of Eocene Sediments in Subsurface of Cape Cod

Abstract. Spores, pollen, and charcoal taken from two wells drilled near the tip of Cape Cod have been identified as Eocene. These are the first Eocene rocks to be identified in Massachusetts. Interpretation of seismic records taken in the Gulf of Maine and Cape Cod Bay will be influenced by this discovery.

Two wells drilled near Provincetown, Mass., on the hook of Cape Cod (Fig. 1) penetrated fluvioglacial material and entered lignitic silts and sand identified as Eocene on the basis of spores, pollen, and foraminifera. Well No. 1 entered Eocene at 86 feet and was still in it at 264 feet. Well No. 2 entered Eocene at 193 feet and was drilled to a total of 203 feet.

The spores and pollen processed by W. S. Hoffmeister from the coal samples at 86 feet 3 inches and at 186 feet from Well No. 1 (Holden's Pond) and at 192 feet 10 inches from Well No. 2 (Stark's Well) have a definite Eocene aspect. Although Upper Cretaceous elements are also present, the evidence points to an Eocene age (probably Lower Eocene). There is a marked similarity between the spores and pollen of these coals and those of a Wilcox (Eocene) sample from Tennessee. Encountering the foraminiferal genus *Elphidium* at 230 feet in the No. 1 well helps to confirm the Eocene age for these sediments, for this genus is not found in material older than Eocene.

No Eocene, in place, had been previously identified from Massachusetts. Coastal plain sediments of Cretaceous and Miocene age crop out at Gay Head on the island of Martha's Vineyard 45 miles southwest of Provincetown. Miocene material resting on granite is known from the subsurface near Duxbury, Mass. (*1*).

In addition to extending the known range of Eocene deposits, discovery of Tertiary sediments beneath the fluvioglacial deposits of Cape Cod is important to marine geophysicists who wish to identify sub-bottom reflections more precisely as to composition and age.

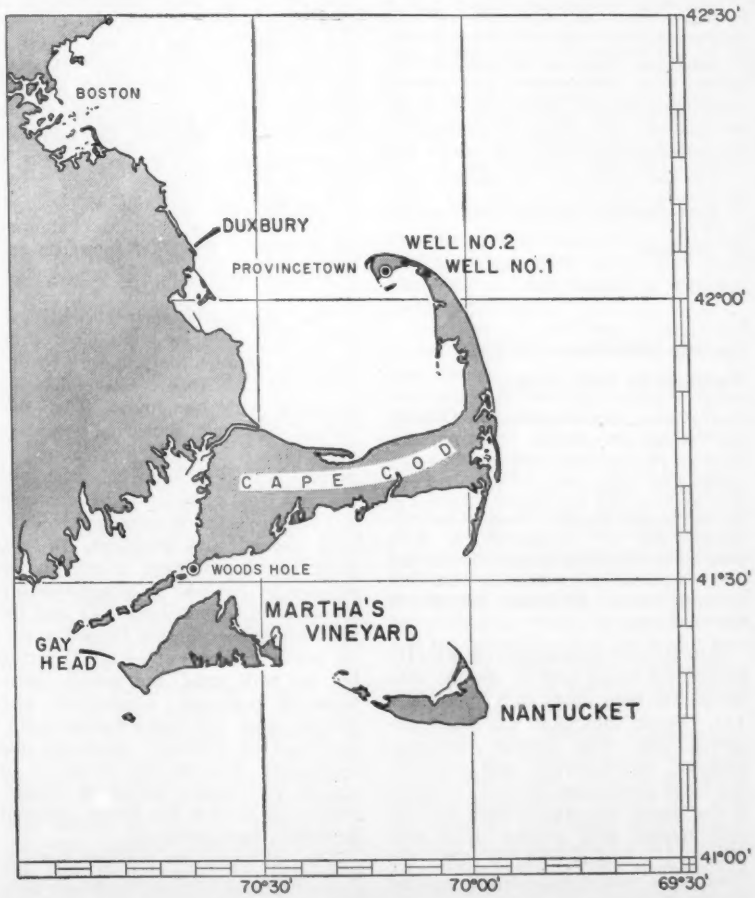

Fig. 1. Cape Cod and surrounding area.

The thickness and extent of Pleistocene deposits overlying reflections interpreted as basement has long been a problem in understanding seismic records from the Cape Cod and Cape Cod Bay area (*2*).

Note added in proof: After this report was submitted for publication, a third well at the westernmost tip of the hook (Race Point) also penetrated Eocene, at 213 feet.

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2. The work was sponsored by the geography branch of the Office of Naval Research under contracts Nonr-1245 (00) NR 388-018 and Nonr-219(6) (00) NR 083-004. We are particularly grateful to Mr. Frank Stark of Provincetown and Mr. Edmond Dalpe, supervisor of Pilgrim Springs State Park, for permitting us to drill on property under their supervision. We express our thanks to Dr. F. P. Shepard, Dr. Carl Hubbs, and Dr. Hans Seuss, of Scripps Institution of Oceanography, for their cooperation in determining a radiocarbon date (older than 42,000 years) from some of the lignitic material. Thanks are due to Hoffmeister's colleagues at the Jersey Production Research Center and to Dr. L. R. Wilson of the University of Oklahoma, all of whom confirmed an Eocene age for these coals. This report is contribution No. 1128 from the Woods Hole Oceanographic Institution.
* Jersey Production Research Company, Tulsa, Okla.

21 July 1960

Specific Inhibition of $RH_o(D)$ Antibody by Sialic Acids

Abstract. Agglutination of $Rh_o(D)$ erythrocytes by specific antiserum was inhibited by crude and crystalline N-acetylneuraminic acid, less inhibited by its glycoyl derivative, and weakly inhibited by its degradation product, N-acetyl-mannosamine, and by D-mannose. A brain ganglioside containing neuraminic acid and a *Pseudomonas* polysaccharide were even more inhibitory. Inhibition was specific for anti-D sera.

Inhibition of agglutination of $Rh_o(D)$ human red blood cells by specific antiserum has been noted with nucleotides (*1*). Weak inhibition has been observed also with certain monosaccharides, streptomycin, and rutinose, the latter being most active (*2*). Since it was shown that eluates from $Rh_o(D)$ cells treated with mumps virus contained a specific inhibitor (*3*), the sialic acids were investigated as possible anti-Rh inhibitors.

Inhibition tests were performed as described previously (*3*), with trypsinized $Rh_o(D)$-positive red cells and either maximal (4+) or partial (2+) agglutinating dilutions of specific anti-Rh human serum (*4*). Complete inhibition of maximal agglutination occurred with both crude and crystalline preparations of N-acetyl neuraminic acid (NANA) (*5*), and when less antibody was used it was 500 times as effective (Table 1). The *p*H of the initial concentration of crystalline NANA in phosphate-buffered saline (*p*H 7.4) was 3.0, but inhibition by samples adjusted to *p*H values of 6.8 to 7.2 with 1.0*N* NaOH was unaffected. Higher concentrations of such samples were required for complete inhibition after storage for 5 weeks in the refrigerator, possibly due to degradation with the formation of N-acetyl-mannosamine. A mixture containing equal parts of the latter substance and N-acetyl-glucosamine (*6*) was inhibitory.

Table 1. Effective concentrations of anti-Rh inhibitors. 4+, maximal agglutinating dilution; 2+, partial agglutinating dilution.

Inhibitor	Anti-D control	Inhibition	
		Complete conc.	Partial (μg/0.1 ml)
NANA (75%)*	4+	500	2
NANA (75%)	2+	1–2	
NANA (3 × crystallized)*			
*p*H 3.0	4+	125	60
*p*H 6.4	4+	150	60
*p*H 6.4†	4+	1000	
1:1 N-gluc–N-mann‡	4+	500	5
D-Mannose	4+	1000	60
Beef-brain ganglioside	4+	150	20
Pseudomonas polysaccharide	4+	500	125
	2+	60	1

* Prepared from bovine submaxillary gland. † Stored 5 weeks in refrigerator. ‡ N-gluc, N-acetyl-glucosamine; N-mann, N-acetyl-mannosamine.

The chemically related N-glycoyl-neuraminic acid also inhibited anti-$Rh_o(D)$ agglutination, but very weakly compared to NANA. Weak inhibition occurred with D-mannose. Two substances of larger molecular-weight, a beef-brain ganglioside containing 17 percent NANA (*5*) and a polysaccharide obtained from a species of *Pseudomonas* (*7*) and suspected of containing NANA, were also effective inhibitors. In fact, these substances were practically as effective as NANA. A ganglioside obtained from human brain (*5*) and the bacterial polysaccharide formed a visible precipitate with anti-$Rh_o(D)$ serum but not with anti-C nor anti-E. Solutions of D-glucose, D-galactose, glucuronic acid, and alpha-D-galacturonic acid were not inhibitory. D-Glucose and D-galactose blocked the inhibition of anti-Rh by partially inhibitory concentrations of NANA, but not by maximal inhibitory concentrations.

The inhibition by purified NANA, N-glycoylneuraminic acid, the ganglioside, and polysaccharide was specific for anti-D, no inhibition being observed with anti-C, anti-E, anti-c, or anti-e sera. The crude NANA, however, demonstrated some inhibition of anti-C and anti-E. Further evidence of specificity was indicated by the production of a positive skin test obtained by the intradermal injection of a dilute solution of the bacterial polysaccharide into the skin of a rabbit passively sensitized 24 hours earlier with anti-$Rh_o(D)$ serum. The reaction varied markedly in severity and time from the reaction produced in a normal rabbit.

Boyd *et al.* (*2*) suggested that the terminal unit of the $Rh_o(D)$ antigen may be one of the sugars belonging to group 4 of Mäkelä's classification (*8*), and noted that streptomycin (a natural glycoside of N-methyl-L-glucosamine) also was inhibitory, while rutinose (6-O (β-L-rhamnosyl)-D-glucose) was five times more effective. Likewise, the larger molecules containing NANA used in our work were more effective inhibitors, and two formed precipitates with anti-Rh serum. It has been suggested (*9*) that sialic (neuraminic) acid occupies a terminal position in gangliosides and mucoproteins. Faillard (*10*) observed that a human brain ganglioside containing 13.2 percent neuraminic acid was resistant to neuramidase, while Gottschalk (*11*) considered that such resistance indicated a ketosidic linkage different from that in compounds susceptible to the enzyme, such as the myxovirus receptor on human erythrocytes.

Since the gangliosides were better inhibitors it may be postulated that the terminal neuraminic acid which is bound in a ketoside linkage conforms more closely to the determinant groups of the $Rh_o(D)$ antigen and exists also in cells containing the antigen. The inhibitory capacity of eluates of human red cells treated with mumps virus or periodate (*3*) might then be due to (i) related products, such as NANA, obtained by the neuramidase action of the virus on the sialic acid of the mucoprotein receptor or its degradation products,

N-acetyl-mannosamine or mannose, or (ii) to the action of periodate on the glycol bonds of more complex carbohydrate structures in carbohydrates similar to these or to those reported by Boyd.

The failure of similar eluates from cells treated with the viruses of influenza and Newcastle disease to inhibit may be due to their more vigorous enzymatic action. The importance of linkage is emphasized by the unpublished results (*12*) obtained in this laboratory, in which human urinary mucoprotein inhibited Rh antibody slightly after incubation with mumps virus, but not after incubation with influenza, NDV, or RDE; stronger inhibition occurred after incubation with trypsin.

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6. Obtained from Dr. Charles W. DeWitt, Research Division, Upjohn Co., Kalamazoo, Mich.
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2 August 1960

Venation Polymorphism and Genetic Variability in Drosophila melanogaster Loew

Abstract. Experimental evidence indicates that phenocopy production may provide an inflated estimate of the importance of genetic variability and recombination in the production of venation phenodeviants.

Some phenotypic characteristics may be misleading indicators of genetic variability. Wing venation variants in *Drosophila melanogaster* Loew are particularly suspect. Milkman (*1*) has recently reported data which he interprets as supporting the notion that a pair of individuals carries "to a large degree the potential variability of the population." He used the first 1000 F_2 progeny of wild inseminated females as samples, and surmises that the appearance of a phenodeviant not present in the female grandparent is an indication of genetic recombination and production of "rare" genotypes.

The presence of four alleles for each locus among the offspring of a mating pair obviously leads to a great number of possible genotypes in the F_2 progeny. This number is not necessarily a large fraction of the total available to the species if many large multiple allelic series exist. This also seems trivial, since with even four alleles at each of five loci (*1*) there are 10^5 possible genotypes, a number far greater than the size of most F_2's examined.

Recombination within and between loci need not be the only source of phenodeviants. Indeed, the possibility exists that among near-homozygous inbred lines environmental variations, even within one culture, could produce such effects.

Thus we have at least two possible explanations for phenodeviants: (i) rare recombinants from highly heterozygous populations, or (ii) theshold effects common to many genotypes, leading to production of phenodeviants in some environments.

An experiment was performed with highly inbred sublines of Canton-S and Oregon-R. The flies were raised at 25 ± 1°C on agar-yeast-sugar–propionic acid food media. The parent stocks were examined each generation during the experiment, as were reciprocal F_1's and F_2's. The wing venation anomalies were recorded and in most cases sketched, and the flies were preserved.

The experiment was repeated by three individuals. Reported variants included extra or missing anterior and posterior cross veins, bifurcations of vein tips, extra venation from the center of cross veins, and other extra venation. Table 1 indicates the overall frequency of venation phenodeviants in each class. Chi-square analysis yielded probabilities between .99 and .30 that the observed differences were due to chance alone.

Neither the combined results nor any of the three replications gave indication of a significant difference in frequency between classes. The most surprising (though a nonsignificant) finding was the low rate of phenodeviants among the F_2's as compared to the other classes. This could indicate that flies in a recombinant population may be less variable in this respect than inbred flies.

In addition it was noted that phenodeviants tended to come in groups from individual culture vials, in any of the classes. This lends some support to the notion that this is a threshold phenomenon requiring particular environmental conditions in addition to genetic conditions.

Table 1. Frequency of venation phenodeviants.

Stock Tested	*N*	Abnormal wing venation (*N*)	Frequency (%)
Canton-S	6,322	30	0.475
Oregon-R	5,676	24	0.423
Canton-S × Oregon-R sum reciprocal F_1's	3,557	17	0.478
Canton-S × Oregon-R sum reciprocal F_2's	12,734	37	0.2905
Sum Oregon-R and Canton-S	11,998	54	0.4501

The data presented indicate that the incidence of venation phenodeviants is not significantly different in the inbred lines, the hybrids, and the F_2 recombinants. If this is the case, then we fail to see how incidence of this type of variation in F_2's of wild inseminated females provides evidence either for or against the existence of "a large degree" of variability in the individuals Milkman (*1*) tested. In a number of our cases the venation phenodeviants were inbred, 50 to 100 offspring were observed, and no phenodeviants were noted. Thus it is unlikely that one or two loci were particularly involved, and it seems very likely that each phenodeviant represented a developmental accident.

Our experiments were carried out under conditions which Milkman (*1*) has indicated are unfavorable to the production of the cross-veinless phenotype. The incidence was actually very low: 0.00017 in the Oregon-R and Canton-S stocks (one sample in each stock). No cross-veinless phenotypes were found among 16,291 F_1's and F_2's examined. Thus, although the cross-veinless phenodeviants could and did appear in the inbred lines, they did not appear among the recombinants. If recombination were to produce this sort of variability, then we would have expected to find more cross-veinless phenotypes among the F_2's than among the parental stocks.

Studies by Dubinin, Dobzhansky, Spencer, and many others have already clearly shown the amazing variability of wild populations. We feel that studies based on such labile characteristics as wing venation anomalies are unlikely to provide more reliable estimates unless an effort is made to distinguish the variability assignable to developmental accidents. The experiment reported

indicates that this type of wing venation variant is relatively common, even in inbred lines, and that F_2 data unsupported by control information of this sort are likely to be misleading.

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8 June 1960

In my paper (*1*) I reported examining 1000 flies in the F_2 of each of 21 wild inseminated *Drosophila melanogaster* females. Of these 21 F_2's, 11 contained flies with defective posterior crossveins. There were 119 such flies among the 21,000 examined, and their distribution among the 11 F_2's was far from random. I cited this distribution, in the light of previous information, as evidence for the abundance of genes in natural populations which, in rare combinations, would greatly increase the probability of a fly's having defective posterior crossveins.

Bennett *et al.* (*2*) cite the morphological variation observed in a highly inbred (and ostensibly isogenic) strain to emphasize the point that morphological variation is not necessarily a reflection of underlying genetic variation. This is, of course, true; the question of cause must be put to any such observation.

I should like to confirm my conclusions with more recent information. I should then like to make some comments on the paper by Bennett *et al.*

First, a repeat of the experiment on later generations of the 21 strains gave good agreement, pointing to the persistence of differences among the strains. Second, I have been able so far to obtain a true-breeding, polygenic, crossveinless (*cve*) strain from each of two of the original strains (*3*). In the absence of intrastrain heterozygosity of *cve* genes, this would of course have been impossible. I should mention, in addition, that the crossvein defects of some of the strains were distinguishable from one another, and that this distinction was the same in both experiments.

Now I should like to discuss certain of the statements in the paper by Bennett *et al.* In the abstract the word *phenocopy* is used. Later, the implication is maintained that the only major alternative to genetic variation, as a cause of phenotypic variation, is environmental variation. In many cases, and very probably in this case of venation variation, a third force is extremely important. Wright (*4*) and Reeve and Robertson (*5*) call it "chance variation," and Waddington (*6*) calls it "developmental noise." Chance variation comprises the indeterminate events with developmental consequences. Although these authors discuss chance variation in terms of later development, it must be of equal importance from the start, for even genetically identical eggs are known to vary in size, content, and maternal environment, and adult structures are not independent of such variation.

Such chance variation is what forces one to designate an array of phenotypes for a given genotype under well-controlled environmental conditions. Such morphological variation in spite of apparently uniform genotype and environment is discussed to some extent in several of the references cited in my paper. The problem, then, is to distinguish the causes of morphological variability.

This distinction can often not be made conclusively on the basis of simultaneous controls. In my experiments, I believe the evidence of genetic variability was good. I should have stated that among the vials of any single strain, *cve* flies appeared to be distributed randomly. Thus the nonrandom distribution of *cve* flies among strains meant that the strains were not identical. Conclusive evidence in such experiments comes, as Bennett *et al.* say, by a sorting out and identification of the factors involved. In the two *cve* strains obtained so far, there are apparently 3 and 2 *cve* genes, respectively. The 3 are each on a different autosome but have not been further localized yet. The 2 strains, which come from different grocery stores, seem to share at least one *cve* gene. None of the other 19 strains seems to have it, supporting the possibility (*1*) that many alternative combinations of genes for making *cve* flies exist.

As to the data reported by Bennett *et al.* I find more contrast than comparison with my own. They did not run 21 parallel lines. And, whereas I reported 119 *cve* flies from 21,000, they report only 2 from 28,000. It is difficult to comment on the exact numbers of *cve* flies to have been expected had they raised their animals at 18°C. Nevertheless, the frequency of all venation variants they report is within the range reported for some groups of wild flies in an extensive study by Dubinin (*7*). This supports Bennett *et al.*'s point that morphological variation, even under controlled environmental conditions, is not definitive proof of genetic variation. I have, incidentally, recorded other unusual forms of venation also. Some are strain-specific, which does point to a genetic basis.

I believe it is relevant to cite experiments conducted in parallel on wild and on inbred strains by Waddington (*8*). He produced a variable morphological response to a given type of heat shock in both, but only the wild strain responded to selection for susceptibility. Bateman has done the same thing (*9*).

One of Dubinin's most significant contributions to the defining of the genetic basis of natural variation was his work with 240 lines from wild inseminated females (*7*). Examination of successive generations led to the observation of venation deviants in 163 strains, the response of some of these strains to selection, and the genetic analysis of certain of the selected strains.

I believe we are in a position now to take a census of *cve* genes and thus begin to record the details of the genetic basis of a representative form of natural variation (*10*). I should be delighted to hear from anyone interested in participating.

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11 August 1960

Demonstration of Canonic Gonial Mitosis and Meiosis in Parascaris equorum

Abstract. It is shown that, contrary to what has been held, separate canonic chromosomes, without fusion into a chromatin mass, occur in the meiotic prophase of *Parascaris equorum*. In mitosis no club-shaped chromosome ends are visible. These results, obtained with a modified fixation procedure, which is described, have been checked by supravital observation.

Mitosis and meiosis in the horse ascaris, *Parascaris equorum* (old name, *Ascaris megalocephala*), have been reported to show several discrepancies in relation to findings in the great majority of animals and plants. Early authors (*1*), described extraordinary phenomena

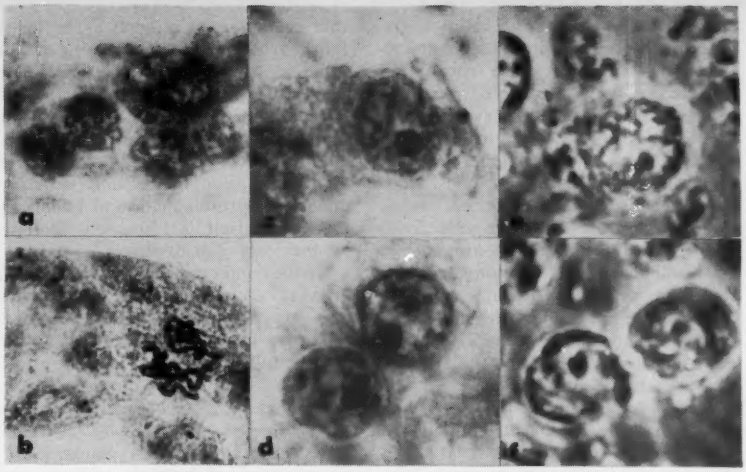

Fig. 1. Photomicrographs of cells of female *Parascaris* (*bivalens*). (*a–d*) Cells fixed in acetic alcohol and stained by Weigert's iron hematoxylin; (*a* and *b*) early and late prophase, respectively, of oögonial mitosis; (*c*) early pachytene stage; (*d*) early diplotene stage. Nucleoli appear as round black bodies. (*e* and *f*) Phase–contrast photomicrographs of living cells in approximately the same stages as *c* and *d*, respectively. (*a* and *b*, × 800; c–f, × 2000)

during meiosis in this species—namely, the aggregation of the two or four chromosomes it possesses (found, respectively, in subspecies *univalens* and *bivalens*) into a common chromatin mass; the occurrence of chromosomes in variable number; and more than one reduction division. Some of these noncanonical aspects have been clarified in more recent times and shown to be due in part to deficiencies in the interpretation of preparations obtained by faulty methods.

Recently it has been reported that *Parascaris* chromosomes are not seen as separate bodies in early meiosis and that they only differentiate themselves from a large chromatin mass, observed in early meiotic prophase, during stages corresponding to late pachytene or early diplotene in other species (*2*, *3*). It was reported that before meiosis, in oögonial mitoses, the chromosomes presented large club-shaped ends which consisted of heterochromatin (*3*), and that this same heterochromatin formed the large chromatic mass of early meiosis and was afterwards "diminished" or eliminated in the somatic cells, during embryonic divisions (*3*).

We have found that these noncanonical findings are artifacts produced through deficient fixation. With appropriate fixation, the chromosomes are observed as separate bodies throughout the entire course of meiosis, no chromatin mass being visible in early meiotic prophase. On the other hand, in gonial mitosis the chromosomes do not show club-shaped ends. After several trials we found that in contrast to usual fixation procedure, which must be as rapid as possible, in this material the cells must be fixed gradually, without osmotic shock, to obtain good results. Acetic-alcohol fixative (glacial acetic acid, 1 volume; absolute alcohol, 3 volumes), strong AFA fixative [96-percent alcohol, 2 volumes; 40-percent formalin solution, 1 volume; glacial acetic acid, 0.1 volume (*4*)], buffered osmic acid, several mixtures of formalin, potassium bichromate, and cadmium or mercury chloride solutions all produce defective fixation when employed in the usual way.

We have obtained good results with the following procedure. The animals, secured from freshly killed horses and immediately brought to the laboratory in the intestinal fluid in which they had lived, were immersed in an isosmotic, 0.25*M* saccharose solution. The fixative was gradually dispensed from a dropping funnel into this solution, with stirring, so that 300 ml of fixative was mixed during 1 hour with the 150 ml of saccharose solution. The worms died within about 10 to 15 minutes after the fixative was first added. At the end of this hour of mixing the animals were immersed in pure fixative, and after another hour the cuticle was cut and the genital tract was exposed to the pure fixative overnight. Acetic-alcohol or strong AFA fixative generally gives good fixation. The second of these fluids is better for preserving nuclear morphology, but it may not preserve so perfectly the materials which give the Feulgen reaction (essentially deoxyribonucleic acid).

Figure 1 shows some aspects of oögonial mitosis and early meiosis, in which no chromatin masses or club-shaped chromosome ends are visible. Two photographs of living meiotic cells, obtained by means of phase contrast, are also shown. From rapidly dissected female ascaris, preparations of segments of the genital tract immersed in the body fluid of the worms were readily made and observed with phase-contrast equipment. The chromosomes were then seen to have the same appearance as after the fixation procedures described here. When fixative was added to these preparations, between slide and cover slip, aggregates and masses appeared and the entire nuclear content became distorted, while the materials of the chromosomes were in part dissolved and afterwards precipitated at random. These supravital observations leave no doubt that phenomena hitherto supposed to be the natural state of *Parascaris* chromosomes are indeed artifacts due to fixation. Our procedure opens the way to a detailed study of mitosis and especially of meiosis in these relatively large chromosomes, which are very interesting owing to their multiple, or so-called diffuse, centromere.

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1 August 1960

Callus Tissues from the Mosses Polytrichum and Atrichum

Abstract. Callus-like tissues, isolated from protonemal cultures of two species of mosses, grow vigorously and without marked differentiation on media containing sucrose, casamino acids, and coconut milk. On mineral agar and on media containing sorbitol the tissue from *Polytrichum* (found diploid) reverts to the growth pattern of apparently normal moss plants.

Relatively undifferentiated and continuously proliferating tissues of diverse vascular plants have been induced by one means or another in past years. These have been listed and described by Gautheret (*1*) under the general categories of *callus* and *tumor* tissues. No representative of the nonvascular plants is included. Allsopp (*2*) has described undifferentiated tissue aggregates from two species of liverwort and has noted that such growths, like

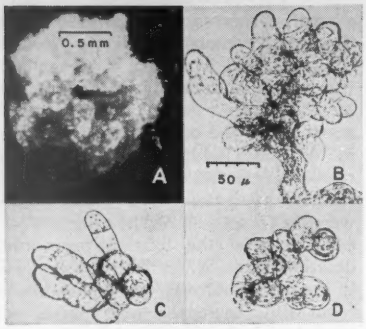

Fig. 1. Habit of tissue aggregate and highly magnified cell detail of callus from *Polytrichum commune* Hedw. *A*, Small mass of actively growing cells *in situ* in petri dish culture two months after planting spores on agar medium (Knudson's with 0.25 percent sucrose supplement). *B*, Single branch of callus aggregate with cells dividing in three dimensions. *C*, Rapidly growing and dividing peripheral cells from individual branch. *D*, Rounded cells produced in callus clumps during less active phases of growth. (Scale in *B* is applicable to all figures of cell detail, which are photomicrographs of unstained tissue made with light through amber filter.)

those in other plants, may be subcultured indefinitely in a continuous callus-like state.

In my studies (*3*), aggregates of callus-like tissue have been isolated from *in vitro* protonemal cultures grown from spores of the mosses *Polytrichum commune* Hedw. and *Atrichum undulatum* (Hedw.) Beauv. Tissue from the former has been subcultured and maintained in the callus condition for well over a year.

The tissue was originally isolated from agar cultures of *Polytrichum* grown on the modified Knudson's basal medium used in earlier experiments with ferns (*4*), supplemented by microelements (*5*) and containing 0.25 percent sucrose (herein called the isolation medium). (The sucrose is believed to have supported growth of the callus to detectable size, since it has rarely been found in mineral agar cultures.)

The callus aggregates are green and autotrophic. They first appeared 2 months after spores were planted, along with the first leaf buds. The tissue grew conspicuously more rapidly than normal protonemata or leaf buds. This rate of growth and undifferentiated habit continued after isolation and subculture. Aggregates of tissue left adjacent to normal protonemata and growing leafy plants displayed a sharp reduction in activity, followed by eventual loss of viability. Sporadic callus aggregates have occurred in subsequent cultures, some of which came from spores collected in widely separated localities.

The tissue aggregates have a rough exterior (Fig. 1*A*). The mass is soft and can be easily teased apart in water. The microscopic structure consists of multitudes of many-branched, semifilamentous processes, with cells dividing irregularly in three dimensions (Fig. 1*B*). Individual cells are elongate under conditions of rapid growth; subsequent cells become rounded as the pattern of division changes and growth becomes less vigorous (Fig. 1, *C*, *D*). All cells are parenchymatous (Fig. 1*D*), and no further differentiation regularly occurs on the isolation medium. It is believed that these aberrant tissues arise from protonemata directly or, possibly, from divisions related to bud formation.

Callus grown on the isolation medium displays a normal, green color (similar to that of plants on either mineral agar or soil); tissues growing on 1 percent sucrose are notably lighter green, but the growth rate is not significantly increased. Growth on sucrose-containing media continues in the absence of light, and the cells retain considerable green color for several months.

The isolation medium plus 0.20 percent casamino acids (Difco, vitamin-free) produces dark green aggregates at a growth rate markedly exceeding that on the former medium. The most rapid growth so far noted for the tissue occurs on agar containing only coconut milk (15 percent) as nutrient. The cells are light green, and the aggregates are very easily fragmented.

Naphthaleneacetic acid (NAA), when added to the isolation medium in concentrations of 1 to 2 mg/liter, induces formation of club-shaped processes on the periphery of the aggregates. The tips of these structures bear a rounded center of meristematic activity, surmounted by imperfect leaflike forms. This growth phase is maintained by continuous subculture on the medium which prompts their initiation; the structures revert to the basic callus pattern on the isolation medium. No progression to normal, leafy plants has resulted on media containing NAA. Cells quite yeastlike in pattern and loosely adherent result from growth on higher concentrations of sugar (1 percent, for instance) supplemented by 1 mg of NAA per liter.

Mineral agar media with sorbitol (500 to 2500 mg/liter) support growth only slightly better than mineral media alone. Adding sorbitol to the isolation medium produces better growth than that occurring on mineral agar, but inferior growth to that occurring on the isolation medium. However, the callus tissues may in time send out many normal protonemata which give rise to buds and slow-growing leafy plants. The growth pattern is here obviously shifted to a resumption of normal (with production of protonemata and buds), and the callus itself is ultimately inhibited by the leafy gametophytes.

Tissues maintained on mineral agar grow slowly, and after several months orderly protonemata from the peripheral cells may give rise to buds and normal plants, fully inhibiting growth of the callus. Subcultures of the latent callus may resume growth on sucrose-containing substrates—media very favorable for growth of normal plants. Leafy plants separated from the callus proper also assume normal growth.

Cytological workers (*6*) have shown the diploid chromosome number of *Polytrichum commune* to be 14. Dividing cells from the callus aggregates so far examined also have this diploid number.

Preliminary trials indicate that up to a tenfold increase in callus incidence may result from treatment of freshly planted spores with x-rays in dosages of about 5000 r. The naturally formed callus and that presumed to be induced through irradiation bear no evident differences in morphology, physiology, or cytology.

Similar undifferentiated tissues from *Atrichum undulatum* have been isolated from an experimental culture receiving 10,000 r x-ray dosage. Whether this tissue is "normal" or induced through irradiation is not yet established. The frequency of occurrence of callus in this species appears tentatively to be much lower than that in *Polytrichum commune*.

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References and Notes

1. R. J. Gautheret, *La Culture des tissus végétaux* (Masson, Paris, 1959).
2. A. Allsopp, *Nature* **179**, 681 (1957).
3. This work was supported by grants from the National Science Foundation (G-6081 and G-8650) and was a part of a research project directed by Prof. R. H. Wetmore as principal investigator under the grants at the Biological Laboratories, Harvard University. The technical assistance of Miss Lydia Thomas is acknowledged, as is the aid of Dr. Otto T. Solbrig in the cytological determinations.
4. M. Ward, *Phytomorphology* **4**, 1 (1954).
5. J. P. Nitsch, *Am. J. Botany* **38**, 566 (1951).
6. A. P. Wylie, *Trans. Brit. Bryol. Soc.* **3**, 260 (1957).
* Present address: Glenville State College, Glenville, West Virginia.

12 July 1960

Association Affairs

Programs Planned for the AAAS New York Meeting

Section and society programs in anthropology and psychology to be presented at the New York meeting are given here. Programs in mathematics, physics, chemistry, astronomy, geology and geography, and the biological sciences have been previously announced [*Science* **132**, 1259 (28 Oct. 1960); **132**, 1318 (4 Nov. 1960)].

Anthropology

Section H. Program chairman for the entire program of Section H is Eleanor Leacock, Bank Street College of Education, New York City.

Symposium, cosponsored by Section F–Zoological Sciences: "Genetics, Evolution and Anthropology," arranged by Howard Levene, Columbia University, with Th. Dobzhansky, Columbia University, presiding; 27 Dec. Papers will be presented on chromosome numbers in primates and their bearing on the evolution of man (John Buettner-Janusch, Yale University); blood groups and racial affinities of the black Caribs of British Honduras (I. Lester Firschein, Columbia University); natural selection and the usefulness of blood groups in physical anthropology (Howard Levene); population genetics aspects of lowered fertility in interfaith marriages (Jack C. Bresler, Brown University). After presentation of the papers, Carleton S. Coon, University of Pennsylvania, will act as discussant.

Symposium, cosponsored by Section I–Psychology: "Interdisciplinary Approach to Methods of Implementing Desegregation," arranged by Ethel Tobach, American Museum of Natural History, and Wagner Bridger, Albert Einstein College of Medicine, with Mary Ellen Goodman, Coordinator of Conference Studies, White House Conference on Children and Youth, presiding; 27 Dec. Paper will be presented on decision-making in the Southern student sit-in movement (Inez Adams, Fisk University); desegregation and integration—an operational distinction (Kenneth Clark, City College of New York); the relationship of behavioral to attitudinal change in desegregation (Stella Chess, New York Medical College); tools of desegregation (Ruth Landes, Claremont, California, Graduate School). After presentation of the papers, Manett Fowler, New York State Department of Health, will act as discussant.

There will be a Section H reception and welcoming remarks on 27 Dec., with Eleanor Leacock presiding. The speaker will be Cornelius Osgood, Yale University, vice president of Section H.

Symposium: "Applied Anthropology: Retrospect and Prospect," with Solon T. Kimball, Columbia University, presiding; 28 Dec. After an introduction by Kimball, papers will be presented on critical analysis of the development of applied anthropology, its contribution to anthropological theory over the past 30 years, and implications for the future (Eliot Chapple, Chapple and Co., and Leonard Sayles, Columbia University). Presentation of the papers will be followed by discussion.

Symposium: "Archeological Salvage," arranged by John L. Cotter, National Park Service, who will preside; 29 Dec. Papers will be presented on river basin salvage—a world view (John O. Brew, Harvard University); highway construction salvage (William A. Ritchie, New York State Museum); U.S. river basin salvage (John M. Corbett, National Park Service); Canadian historic sites conservation (Richard C. Forbis, Glenbow Foundation, Calgary, Alberta, Canada); techniques and tools of archeological salvage (W. W. Wasley, University of Arizona); contributions of physics to archeological conservation (R. E. Linington, Oxford University); accomplishments of prehistoric site salvage in the Southwest United States (Alexander J. Lindsay, Jr., Northern Arizona Society of Art and Science); archeological conservation in the People's Republic of China (Frank Ridley, Ontario Archaeological Society); archeological site salvage in Great Britain (Ivor Noel Hume, Colonial Williamsburg). Presentation of the papers will be followed by a general discussion and a summary by John L. Cotter.

Symposium: "The Development of New Nations," arranged by Elliott P. Skinner, New York University, who will preside; 29 Dec. Papers will be presented on the nature of new leadership in West Africa (Hugh H. Smythe, Brooklyn College); tribal politics in Nigeria (Stanley Diamond, Brandeis University); nativistic movements and new national states in Southeast Asia (John Landgraf, New York University); colonialism, nationalism, and parochialism in the West Indies (Vera Rubin, Research Institute for the Study of Man). After presentation of the papers, John Murra, Vassar College, will act as discussant.

There will be a session for contributed papers on social anthropology on 30 Dec., with Rhoda Metraux, American Museum of Natural History, presiding.

Symposium, cosponsored by Section I–Psychology: "Language and Cognition," with Joseph H. Greenberg, Columbia University, presiding; 30 Dec. Papers will be presented on neurological bases of language acquisition (Eric Lenneberg, Harvard Medical School); the Whorfian hypothesis—a re-evaluation (Joshua Fishman, Yeshiva University); the role of language in the cognitive processes of middle- and lower-class children (Vera John, New York Medical College); a search for existential terms referring to engagement and exuberance (Dorothy Lee, Harvard University).

Symposium: "Theories and Models of Energy in Human Society," with Richard N. Adams and Steven Polgar, University of California, Berkeley, presiding; 31 Dec. Papers will be presented on energy-maximizing tendencies of primitive economics (Peter Vayda, Columbia University); trial qualification of a culture energy model (Marvin Harris, Columbia University); energy, technology, and social organization (Anthony Leeds, City College); energy and expanding systems (Richard N. Adams, University of California, Berkeley); the thermodynamic imperative (Steven Polgar, University of California, Berkeley). After presentation of the papers there will be a panel discussion by W. F. Cottrell (Miami University), Jean Mayer (Harvard University, and Eugene Odum (University of Georgia).

Section H is a cosponsor of the symposium of the Ecological Society of America: "Ecology and Anthropology," arranged by Paul Baker, Pennsylvania State University, who will preside; 28 Dec. Papers will be presented on ecology and nutritional stress in man (Marshall Newman, United States Naval Museum); cultural ecology of Teotihuacan Valley (William Sanders, Pennsylvania State University); application of ecology to physical anthropology (Frank Livingston, University

of Michigan); cultural ecology and ethnography (Charles Frake, Stanford University); the application of ecological theory to recent anthropology (Paul Baker).

Psychology

Section I. Symposium: "The Physiology of Feeding and Drinking Behavior," arranged by Eliot Stellar, University of Pennsylvania Medical School, who will preside; 29 Dec. Papers will be presented on eating and drinking behavior in various types of obese animals (Jean Mayer, Harvard University School of Public Health); changes in feeding behavior produced by intrahypothalamic chemical injection (Alan N. Epstein, University of Pennsylvania Medical School); the relative importance of adipsia and aphagia in the lateral hypothalamic syndrome (Philip Teitelbaum, University of Pennsylvania, and Alan N. Epstein); experimental hyperphagia in the rhesus monkey (Charles L. Hamilton, Coatesville, Pa., Veterans' Administration Hospital, and John R. Brobeck, University of Pennsylvania Medical School); an experimental analysis of self control of eating behavior (Charles B. Ferster, Indiana University Medical Center). After presentation of the papers, Peter J. Morgane (University of Tennessee Medical School), Harold Graff (Institute of the Pennsylvania Hospital), and Albert Stunkard (Hospital of the University of Pennsylvania) will act as discussants.

There will be a Section I Executive Committee meeting and luncheon on 29 Dec.

Section I vice-presidential address: "The Neural Encoding of Sensory Information," by Clifford T. Morgan, University of Wisconsin, vice president for Section I, with Frank W. Finger, University of Virginia, presiding; 29 Dec.

Symposium: "Some Recent Approaches to the Learning of Concepts," arranged by Roger N. Shepard, Bell Telephone Laboratories, Murray Hill, N.J., who will preside; 29 Dec. Papers will be presented on computer simulation of concept attainment (Carl I. Hovland and Earl Hunt, Yale University); a model for random selection of strategies (Frank Restle, Michigan State University); the development of concepts under noncontingent reinforcement (Herbert M. Jenkins, Bell Telephone Laboratories); conceptual learning of social relations (Clinton B. DeSoto, Johns Hopkins University).

Symposium: "Applications of Behavior Technology," arranged by Murray Sidman, Walter Reed Army Institute of Research, who will preside; 30 Dec. Papers will be presented on behavioral problems in radiation research (Robert Clark, Walter Reed Army Institute of Research); education as a problem in behavioral manipulation (James G. Holland, Harvard University); the social manipulation of verbal behavior (Arthur J. Bachrach, University of Virginia Medical School); behavior deviations in children: autism (Charles B. Ferster, Indiana University Medical Center); the use of behavior and of behavioral variables in industry (Thom Verhave, Eli Lilli and Company). After presentation of the papers, Joseph V. Brady, Walter Reed Army Institute of Research, will act as discussant.

Symposium: "Theories of the Visual Contrast Threshold," arranged by Robert M. Boynton, University of Rochester, with Conrad G. Mueller, Columbia University, presiding; 30 Dec. Papers will be presented on psychophysical theories of the visual contrast threshold (Richard H. Blackwell, Ohio State University Institute for Research in Vision) and on quantum efficiency of vision (R. Clark Jones, Polaroid Corporation, Cambridge, Mass.).

Section I is cosponsor of the following programs: two symposia of Section H, "Interdisciplinary Approach to Methods of Implementing Desegregation," 27 Dec., and "Language and Cognition," 30 Dec. (see Section H), and the five-session symposium of the American Psychiatric Association, "Expression of the Emotions in Man," 29 and 30 Dec. (see Section N).

Social and Economic Sciences

Section K. Symposium, cosponsored by the American Political Science Association and the National Institute of Social and Behavioral Science: "Some Perspectives on Political Science and Science," arranged by Donald P. Ray, National Institute of Social and Behavioral Science, with Carl B. Swisher, Johns Hopkins University and the American Political Science Association, presiding; 27 Dec. Following the vice-presidential address of Section K, "On Science and the Polity," by Pendleton Herring, papers will be presented on bases of local political influence in a democracy (Robert A. Dahl, Yale University) and on scientists and American science policy (Wallace S. Sayre, Columbia University).

AAAS interdisciplinary symposium in the social sciences, joint program of Sections E–Geology and Geography, K–Social and Economic Sciences, O–Agriculture, P–Industrial Science, and the Association of American Geographers: "The Urban Frontier: A Conquest of Inner Space," arranged by Firman E. Bear (Rutgers State University), Frank C. Whitmore, Jr. (U.S. Geological Survey), and Charles C. Morrison, Jr. (American Geographical Society), with James E. Lash (Action, Inc.) presiding; 28 Dec. Papers will be presented on the application of census statistics to problems of urban renewal (A. Ross Eckler, Bureau of the Census); urban renewal and metropolitan affairs (Martin Millspaugh, Charles Center, Baltimore); two basic issues in local renewal policy (Coleman Woodbury, University of Wisconsin); renewal for industry—the opportunity and the problem (Dorothy A. Muncy, Consulting City Planner, Arlington, Va.); Newark, New Jersey—a case study in urban renewal (Paul Busse, Newark Economic Development Committee); urban renewal in New York City (George M. Raymond, Pratt Institute).

There will be two sessions for contributed papers, arranged by Donald P. Ray, who will preside; 30 and 31 Dec.

Section K is also the cosponsor of the two symposia of the American Sociological Association, 28 and 29 Dec., and the two symposia of the New York Area Chapter of the American Statistical Association, 29 and 30 Dec. (see the programs of these societies).

American Economic Association. Invited papers, cosponsored by Section K: "The Economics of Science," arranged by Kenneth E. Boulding, University of Michigan, and Samuel J. Mantel, Case Institute of Technology, with Boulding presiding; 26 Dec. Papers will be presented on the impact of research and development on the growth of industry (Samuel J. Mantel and S. S. Sengupta, Case Institute of Technology); the economics of scientific research in the United States (Jacob Perlman, National Science Foundation); growth, cycles, and invention (Jacob Schmookler, University of Minnesota). After presentation of the papers, Father William T. Hogan (Fordham University), and Wroe Alderson (Alderson Associates, Inc., Philadelphia), will act as discussants.

American Society of Criminology. The entire program of the American Society of Criminology is cosponsored by the Medical Correctional Association.

Session I: "Psychiatry, Criminology and the Offender," with Marcel Frym (president of the American Society of Criminology) as chairman, Charles Newman (Kent School of Social Work, University of Louisville) as discussion leader, and Jacob Chwast (Educational Alliance, New York City) as rapporteur; 26 Dec. Papers will be presented on the psychiatric aftereffects of imprisonment (Melitta Schmideberg, Association for the Psychiatric Treatment of Offenders); the social psychology of judges and judicial decisions (Israel Gerver, Brooklyn College); a psychoanalytic approach to the female homo-

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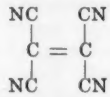
Just carbon and nitrogen

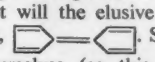
A family of Frenchmen ran a powder mill down on Brandywine Creek in Delaware. They attracted some smart chemists to work for them and branched out. The chemists attracted other chemists and they got quite a thing going.

On June 4, 1957, U. S. Patent No. 2,794,824 was granted to two of these chemists for the preparation of a compound called tetracyanoethylene, which contains only carbon and nitrogen.



Tetracyanoethylene stirred up attention from chemists all over, particularly after the inventors and their buddies let on that

1) though it survives 600° unchanged, when it catches fire in oxygen it burns hotter than does acetylene-oxygen;
2) it reacts with compounds like dimethylaniline to give a new class of intensely colored dyes, the tricyanovinyls, that might some day go commercial for hydrophobic fibers;
3) it can be converted to hexacyanoisobutylene, a dibasic acid so strong that in 0.4M solution it shows pH 1.7 (as compared with pH 1.8 for sulfuric at the same molarity), with a very stable ion containing nothing but carbon and nitrogen;
4) it is far speedier even than maleic anhydride at forming a ring with a diene, Diels-Alderwise;
5) its solutions in various aromatic hydrocarbons are intensely and differently colored, each characteristic of the availability of electrons from the hydrocarbon.

From across town here in Rochester came the idea of using that π-electron transfer to identify by color the spots on paper chromatograms of aromatic hydrocarbons instead of having to pull down the window shades for ultraviolet work. An oil company in Houston found that while these spots lost their color on heating, the spots from nitrogen-bearing aromatics after heating gave a new series of characteristic colors. At Yale, tetracyanoethylene captured and held for release at will the elusive compound fulvalene,  . So it went.

We ourselves (as this very page strives to remind you) were spawned by a snapshooting camera. One direction in which *we* branched out was the business of supplying organics for research and analytical use. Chemists asked us for tetracyanoethylene. We turned toward the Brandywine and asked permission to make a little under U. S. Patent No. 2,794,824. Back came a suggestion—that the Frenchmen's successors in interest make it and sell us some for resale in conveniently small quantities. Since this saved them and us and the rest of the chemical world a lot of bother, *Tetracyanoethylene* from Delaware is now obtainable as Eastman 7883. If you want to write them for general cyanocarbon information, we have their name and address around here somewhere.

Abstracts of the analytical procedures we can supply gratis. Likewise our latest catalog, Eastman Organic Chemicals, List No. 42. Tetracyanoethylene, *Eastman 7883, will cost you $2.65 for 1 gram. Any or all from Distillation Products Industries, Rochester 3, N. Y. (Division of Eastman Kodak Company).*

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Royal-X Pan	1250
Roll Films	**ASA**
Panatomic-X	40
Verichrome Pan	125
Plus-X Pan Professional	160
Tri-X Pan	400
Royal-X Pan	1250
35mm Films	**ASA**
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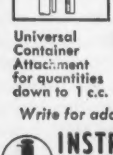

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sexual (Richard C. Robertiello, author of *Voyage from Lesbos*); psychopathology of the sex offender (Ralph Brancale, New Jersey State Diagnostic Center); the Fourth International Congress of Criminology—an analytic commentary (Hector Ritey, New York City).

Session II: "New Approaches to Continuing Problems in Crime Control," with Vernon Fox (Florida State University) as chairman, Clyde Vedder (Northern Illinois University) as discussion leader, and Lee Lawder (editor of *Law and Order*) as rapporteur; 26 Dec. Papers will be presented on problems in organizing and directing a citizens' crime commission (Alvin J. T. Zumbrun, Maryland Crime Investigating Committee); the nature of an interdisciplinary center approach to delinquency problems (Kenneth Kindelsperger, Youth Development Center, Syracuse University); justice through science—the role of the university in professionalizing law enforcement (Paul B. Weston, Sacramento State College); a killer without a motive (James A. Reinhardt, University of Nebraska); the White House Conference on Children and Youth—comment and criticism (Lois Higgins, Crime Prevention Bureau, Chicago; president, International Association of Women Police).

The American Society of Criminology will hold a business meeting on 26 Dec. with Marcel Frym as chairman. Reports will be given on the Second United Nations Congress on Crime and Delinquency (Marcel Frym) and on the Second International Meeting on Forensic Medicine and Pathology (Donal E. J. MacNamara, American Society of Criminology). Election of officers will follow these reports and a report of the planning chairman of the International Criminological Congress of 1961 (John Kenney, University of Southern California).

Session III: "Reaching the Anti-Social Gang," with Jacob Chwast (Educational Alliance) as chairman, Harris Peck (New York City) as discussion leader, and Canio L. Zarrilli (New York Institute of Criminology) as rapporteur; 27 Dec. Papers will be presented on social-work ethics and law enforcement —a dilemma (Russell Hogrefe, Chicago Youth Centers); the organization and behavior of violent gangs (Lewis Yablonsky, University of Massachusetts); reaching the fighting gang—New York's experience (Hugh Johnson, New York City Youth Board); a summer program in delinquency prevention and control (Arthur Clinton, New York City Board of Education); and the juvenile in detention—standards and problems (Sherwood Norman, National Institute of Crime and Delinquency).

Session IV: "Research and Theory in Criminology and Penology," with John Kenney as chairman, Herbert Block (Brooklyn College) as discussion leader, and Margaret Scott MacNamara (Brooklyn College) as rapporteur; 27 Dec. Papers will be presented on the Raiford study — alcohol and crime (Shaw Grigsby, University of Florida); conflicts and cooperation in criminology (Albert Morris, Boston University); containment theory — a new operational theory for criminologists (Walter Reckless, Ohio State University); criminal responsibility as a scientific concept—a crucial issue in criminology and corrections (Frank Hartung, Wayne State University); squirrel-cage penology—the rotary jail (Walter Lunden, Iowa State University of Science and Technology).

The Society will have its Annual Awards and Memorial Session on 27 Dec., with Donal E. J. MacNamara as chairman. The program will consist of a memorial address (Jerome Nathanson, Society for Ethical Culture); presentation of the 1960 Annual Award of the American Society of Criminology (Hon. James Bennett, U.S. Bureau of Prisons); an address by an award recipient (Thorsten Sellin, International Criminology Society); two presentations of the August Vollmer Award for Research in Criminology (Vernon Fox, Florida State University, and Marcel Frym); an address on patterns of criminal homicide (Marvin E. Wolfgang, University of Pennsylvania); an address on African homicide and suicide (Paul Bohannan, Northwestern University).

American Sociological Association. Invited papers, cosponsored by Section K: "Sociology of Science: Organization of Research," with Vincent H. Whitney, University of Pennsylvania, presiding; 28 Dec. Papers will be presented on organization and authority in the industrial research laboratory (Simon Marcson, Princeton University and Rutgers State University); organizational pressures and role strains in an industrial laboratory (William Evan, Bell Telephone Laboratories); research administration and the administrator—the U.S.S.R. and the U.S.A. (Norman Kaplan, Cornell University); industrial scientists and the values of science (David N. Solomon and Silvia Lamb, McGill University).

Invited papers, cosponsored by the Population Association of America and Section K: "Populations, Trends, and Policies in the Communist Countries," with Vincent H. Whitney presiding. Papers will be presented on population change and policy in Eastern Europe (Jerry W. Combs, Jr., Foreign Manpower Research Office, Bureau of the Census); demographic development of the Soviet Union (John F. Kantner,

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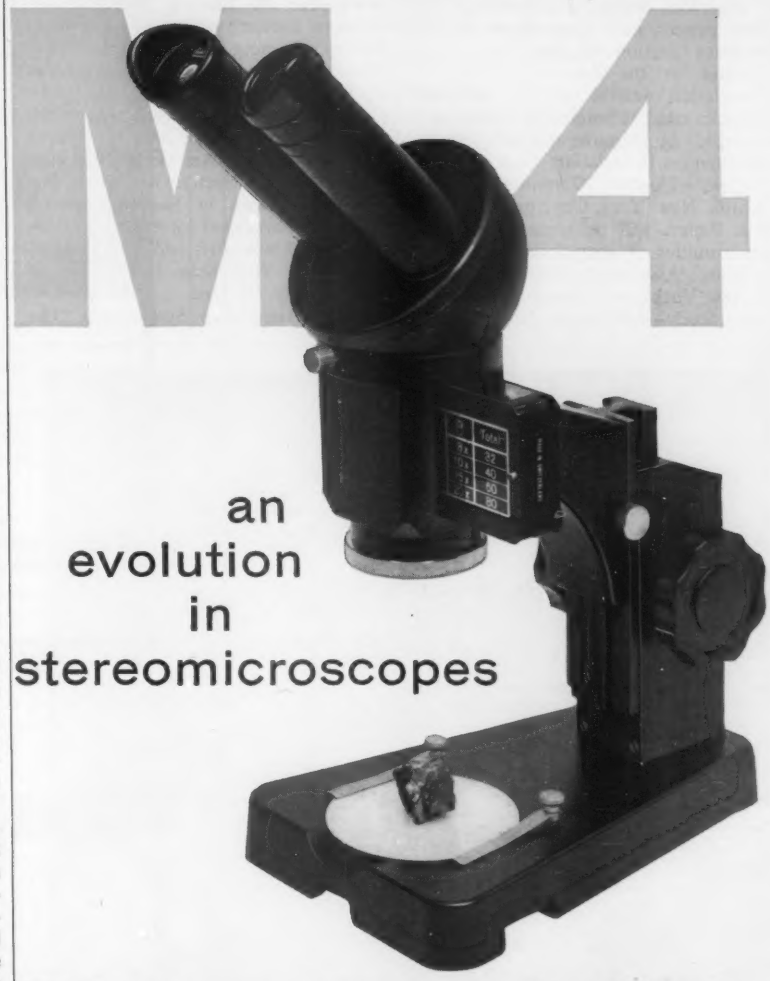

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Population Council); Communism, culture, and population—China as a case study (Irene Taeuber, Princeton University).

American Statistical Association. Invited papers, joint program of the Biometrics Section of the New York Chapter of the American Statistical Association, and Section K: "Hospital Statistics and Community Planning," arranged by Monroe Lerner, Health Information Foundation, with Paul M. Densen, Deputy Commissioner of Health, New York City, presiding; 29 Dec. Papers will be presented on the opportunities of operation (J. Douglas Colman, Associated Hospital Service of New York); the Massachusetts Hospital Study—collecting data through survey research (Paul Sheatsley, National Opinion Research Center, University of Chicago); hospital use in Indiana and in Saskatchewan by diagnosis—use of existing hospital data (Monroe Lerner); hospital data in community planning for the aged (Marta Frankel, New York City Department of Hospitals).

Invited papers, joint program of the Biometrics Section of the New York Chapter of the American Statistical Association and Section K: "Some Statistical Problems in Social Insurance Research," arranged by Abram J. Jaffe, Columbia University, and Nathan Morrison, New York State Department of Employment; 30 Dec.

Metric Association. Symposium: "The Current Interest in the Adoption of the Metric System," arranged by J. T. Johnson, president of the Metric Association; 27 Dec. After introductory remarks by J. T. Johnson, papers will be presented on the timeliness of the metric question (Hon. Lewis L. Strauss, former Secretary of Commerce); problems, progress and proposals for resolving some of the confusion on units in the U.S.A. (Carl F. Kayan, Columbia University); the evidences of current interests in the metric question here and abroad (Robert P. Fischelis, National Drug Trade Conference); what can and should be done for reviving activities in the Metric Association (K. E. Ettinger, Consulting Engineer, New York City); future plans for the Metric Association (Fred J. Helgren, Secretary-Treasurer, Metric Association). The symposium will be followed by an informal dutch-treat luncheon at which there will be continued discussion of the metric question. The luncheon is for those who are interested in the discussion, and especially for those interested in the Metric Association.

National Academy of Economics and Political Science. Invited papers, cosponsored by Pi Gamma Mu: "The Research Revolution and Public Policy," arranged by Amos E. Taylor, National Academy of Economics and Political Science, with John Green, U.S. Department of Commerce, presiding; 29 Dec. Papers will be presented on the research revolution and its economic implications (Leonard Silk, *Business Week,* McGraw-Hill Publishing Company) and on public policy and the intersectoral flow of funds for research and development in the United States (Jacob Perlman, National Science Foundation).

National Institute of Social and Behavioral Science. Cosponsor of the symposium of Section K, "Some Perspectives on Political Science and Science," 27 Dec. The Institute will also cosponsor Session V of the National Science Teachers Association, 30 Dec., in which there will be an address on biology of the mind by Irwin J. Kopin, National Institute of Mental Health, and a panel discussion (for details, see Section Q).

Social Science Research Council. Cosponsor of the AAAS symposium on the sciences in Communist China. Part IV, "Agriculture and the Social Sciences," will be of particular interest to social scientists. There will be a paper on scientists and the community (Theodore Chen, University of Southern California), a paper on organization and development of science (John M. H. Lindbeck, Harvard University), and a paper on anthropology, linguistics, and archeology (Francis L. K. Hsu, Northwestern University); 27 Dec.

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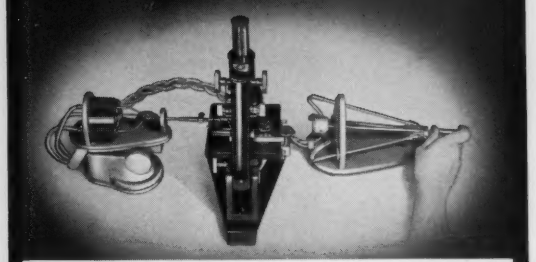

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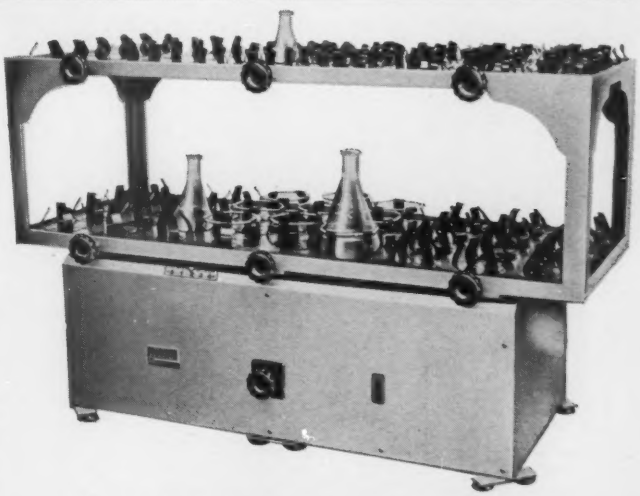

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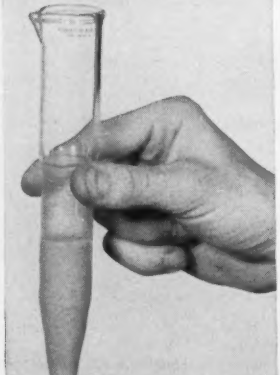

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Letters

Biological Organization

Ehret's interesting article [*Science* **132**, 115 (1960)] deserves some comment regarding the evidence for the evolution of cell structure. The classification of cells on the basis of envelope systems lacks phylogenetic soundness for it is necessary to place some viruses, bacteria, and actinomycetes in all envelope groups; this can certainly not be an accurate classification on the basis of their evolutionary position. The primary difficulty, however, lies in the proposition that bacteria and actinomycetes form a class of inner or single envelope organisms, the plasma membrane of which would correspond to the nuclear membrane of two envelope systems or advanced cell types. This would imply a mechanism of cellular evolution in which the cytoplasm and cell organelles form outside the protobiote (nucleus). It is well to note that all nuclear membranes, unlike the bacterial protoplast membrane, are double, being formed of sacs of endoplasmic reticulum which are organized and flattened against the phase which they surround. The bacterial protoplast contains those enzymes that are found in the cytoplasm but are absent from the nucleus of higher cell types.

Endoplasmic reticulum in higher cell types is frequently seen to be continuous with the plasma membrane, and the outer component of the perinuclear cisternae, with the endoplasmic reticulum. Indeed, in some fungi the membranes appear to be a continuous system all associated with the plasma membrane [*Exptl. Cell Research* **16**, 689 (1958)]. These continuities in some cases occur by means of connections which resemble circumferential, centripetal infoldings of the plasma membrane, which, instead of cutting the cell in two as in bacterial cell division, spread over the nucleoid as in the early stages of bacterial spore formation. This appears to be the only evidence for the evolutionary origins of the nuclear envelope at the present time, and it seems therefore to be the best. The envelope theory makes little sense when one attempts to apply it to this schema.

The formation of the endomembranes of higher cell types does, indeed, appear to have involved two steps: (i) membrane invagination as a modification of the cytocinetic mechanism, and (ii) a progression from obligate to facultative membrane continuity. If the envelope theory is applied to bacteria, then it would be the inner envelope rather than the outer which is missing. I would suggest abandoning

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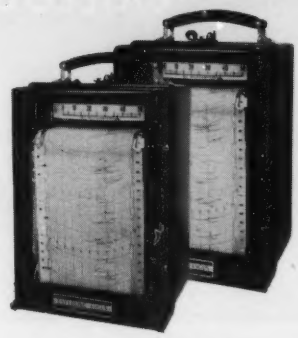

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the envelope idea, because it is unrealistic from the phylogenetic point of view and relies upon assumptions which are unsupported.

I would submit that at present the best defensible hypothesis regarding the relationships among membranes is the following: "All cellular membranes are phylogenetically derived from the plasma membrane and share with it the capacity to become structurally differentiated by the specific association of proteins thereon in genetically determined patterns" [J. H. McAlear, thesis, Harvard University (1958)]. I would further submit that attempting to apply mathematical rigor to morphology at any level, at this time, must only result in a pseudosophisticated over-simplification. The study of the evolution of morphology is an inductive process and requires the accumulation of information of a comparative nature.

JAMES H. MCALEAR
Division of Laboratories and Research, New York State Department of Health, Albany

The article by C. F. Ehret entitled "Organelle systems and biological organization" expounds a view of the nature of living things that many of us thought had disappeared with the advent of evolutionary theory. It purports to be an account of certain entities obeying natural laws, termed "macromolecular aggregates" and "organelles." This is an inherently misleading approach to what are, in fact, biochemical and biophysical problems, because it deals with words from biological discourse as though they had the same kind of referents as similar words in physics.

There are, indeed, subatomic particles, atoms, and molecules which follow certain physical laws. A general class of larger things also exists—namely, the class of physical objects, obeying the laws of mechanics (relativistic or classical). The biological world does not contain classes of this variety, because its "components" have evolved according to their adaptive fitness to survive in various environments and not according to any internal "laws" of a paraphysical kind. Similarities between organelles, such as those mentioned by Ehret, demonstrate not a common law but a common origin. Likewise, the differences between bacteria and cellular organisms, about which Ehret makes such far-fetched topological play, demonstrate not two fundamentally opposed "patterns" derived from any natural law of cell construction but a more remote common origin.

One might also have thought that the "free-living nucleus" hypothesis—never a very likely one—would have

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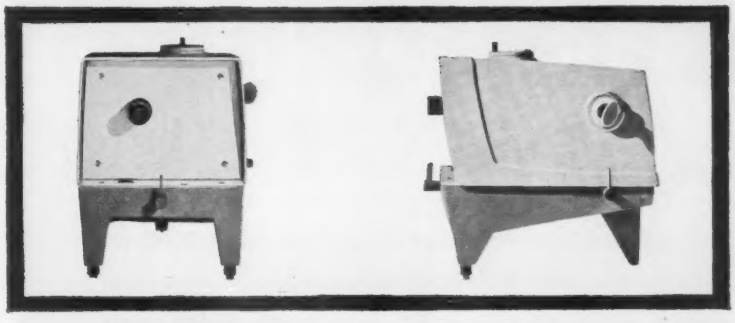

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been scotched by recent work in bacterial biochemistry. But Ehret does not discuss biochemistry at all, because it does not fit into his formal framework. In his critique of the specification of organelles, by function, he claims (citing only a personal communication) that structurally typical but nonrespiratory mitochondria occur in a yeast mutant. He totally ignores all the most important work in this field since 1945, by such people as Chance, Lehninger, Green, Greville, Slater, Schneider, and many others, who show how close a relationship exists in the mitochondrion between structure and biochemical functioning. To say of such an organelle that its primary role is "niche-filling" or "space-filling" is either absurd or meaningless. In fact, the role of these structures seems to be to maintain the proper environments for certain reaction sequences, the structure being itself modified according to the reactions occurring within it [see, for example, L. Packer and A. L. Tappel, *J. Biol. Chem.* **234**, 525 (1960)]. Ehret's hypothesis of a role for such organelles concerned with "transmission, diffraction, oscillation [sic], and reception of electromagnetic energy" seems to be a deliberate attempt to confuse the issue as regards the well-founded chemical roles of such systems and also smacks of the aberrations of such pseudoscientific cults as "radionics."

In developing his peculiar *Weltanschauung*, Ehret makes various mistakes of fact and nomenclature. To refer to cilia from different organisms as "isotopes" is just wrong; a word exists to describe the relationship—namely, *homology*, which indicates a common evolutionary origin. To state that all cilia are homologous is to put forward an interesting theory about show. I find the meaning of his other statement on this issue, that "all particle sense. And what on earth are "non-atoms" (Fig. 7)?

His claim that "at the molecular level . . . the interacting particles . . . have relatively infinitesimal lifetimes" is untrue, as a glance at the half-lives for various types of cellular component, obtained by radioisotope labeling or other methods, would suffice to show. I find the meaning of his other statement on this issue, that "all particle concepts suffer from illusions of the reality of a static point," not entirely clear.

Ehret says that by his method, the "gap between the molecular and cellular levels is realistically bridged." It is difficult to see why the need for such a "bridge" was ever felt. The link between the physical and biological worlds is provided by the theory of evolution. "Nous n'avons pas besoin de ces autres hypothèses."

The editorial in the same issue of *Science* takes exception to a popular article about scientific things written in an anthropomorphic manner. In the circumstances, there is a temptation to cry "Tu quoque."

PETER NICHOLLS
Science Research Institute,
Oregon State College, Corvallis

McAlear's opening remarks regarding incongruity are based upon an erroneous notion about the relationships that are required between structural and phylogenetic categories. In taxonomy we frequently classify organisms with abbreviated life cycles on the basis of their larval stages, despite the absence of a terminal stage of development "normal" to their category; HeLa tissue cultures the world over remain generically *Homo* despite their structural simplicity and instability; each of us has arisen from a fertilized egg, structurally a microorganism but phylogenetically human; at the subcellular level, the transplanted frog nucleus remains phylogenetically an amphibian. But consider the interesting case of *Pneumococcus* transforming deoxyribonucleic acid, which retains only some of its host's phylogenetic

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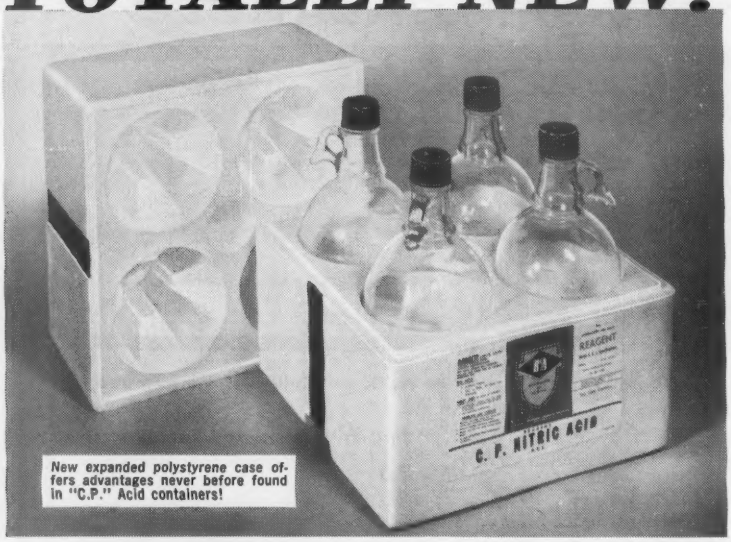

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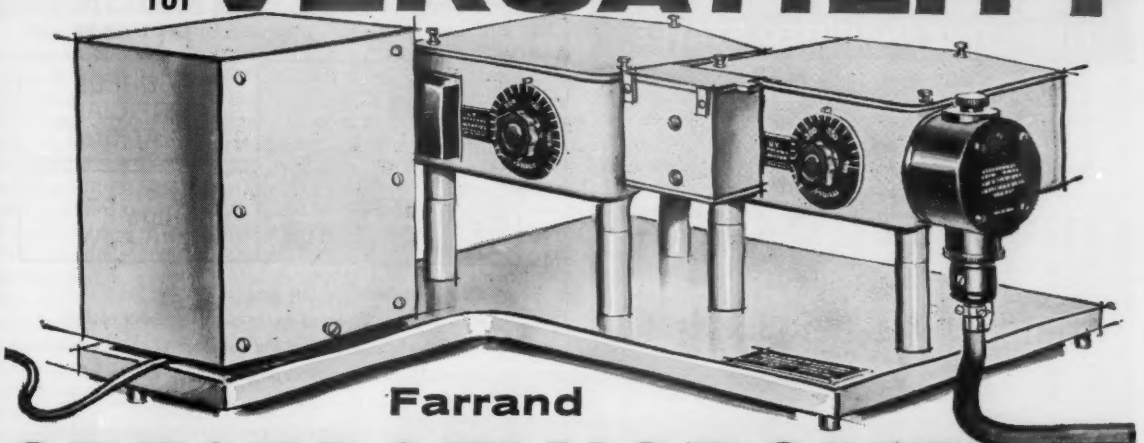

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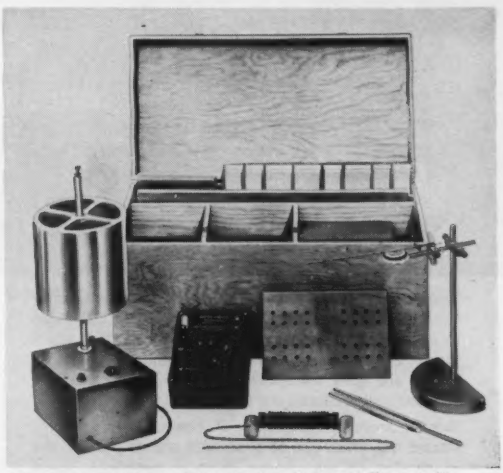

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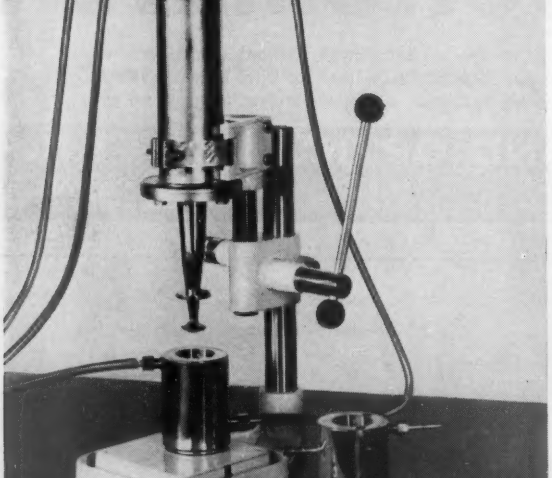

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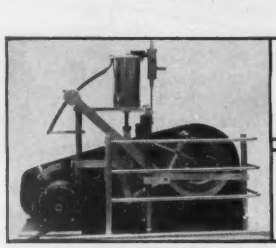

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character; these structural units are smaller than the minimal phylogenetic unit, which is sensibly an approximation of the organism's entire genome.

The well-known relationships between endoplasmic reticulum and nuclear membrane are not only consistent with but a part of my central thesis. We must, of course, eventually account for the specific structural differences between nuclear membranes and bacterial envelopes, as well as for those between different nuclear membranes and between different bacterial envelopes. The envelope-system method of classification simply places central emphasis upon the interesting topological properties (especially the inside-outside relationships) associated with the various known and possible forms of cellular organization. Numerous alternative speculations, including McAlear's, are compatible with it (no test of their soundness). From the evolutionary viewpoint, gene mutation and selection have produced the diversity of outer wrappers seen in bacteria and could easily account for such specific differences as are known between nuclear membranes and bacterial envelopes. Basic to this must be both gene-product differences and environmental phase differences: the nuclear membrane is at a karyoplasm-cytoplasm interface; the bacterial envelope, at a "karyoplasm"-substrate interface. In this regard, it should be interesting to compare the "karyoplasm"-substrate interface (normal envelope) with a "karyoplasm"-host cytoplasm interface in the case of facultative intracellular symbionts or parasites.

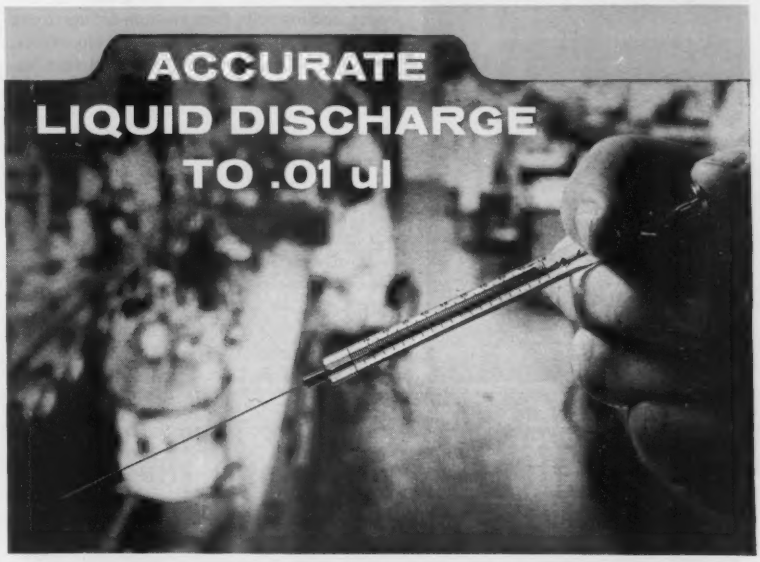
Regarding the evolution of cell structure, there is, of course, no direct evidence. The fossil record offers little help at the subcellular level, and all extant "living fossils," from coelacanths to protozoa, are 1960 models, most of which appear to be in an evolutionary cul-de-sac. From this point of view a word like *protozoa* is etymologically acceptable; in this sense and within the context of the discussion of envelope systems I have lumped bacteria and actinomycetes as "protobiotes." Whether they represent primitive or degenerative forms of life has been argued brilliantly, but also fruitlessly and *ad nauseam*, in a voluminous literature.

Irrespective of how any particular system has actually evolved, the presence in multienvelope systems of a unique ensemble of organelles unquestionably permits the development of cytoplasmic structures of greater diversity than is possible without them. This follows of logical necessity, as should be obvious if one considers the physical basis of diversity: for example, generically more structural forms are possible in a 100-atom than in a ten-atom system. The first appearance, then, of such a supramolecular unit as a cilium is surely to be regarded as a major innovation within the bios, and the subsequent capitalizations upon such units are indeed remarkable achievements in the evolution of metazoa.

In the history of science, logical rigor, though always difficult in virgin territory, has been indispensable for progress; it has invariably led to oversimplification, and as mortals the best we can hope for is an orderly progression from good oversimplifications to better ones.

It is commonplace to ridicule by unsupported generalizations that which one does not understand, and in both respects Nicholls has succeeded beautifully. In the spirit of substituting light for heat, I shall comment on the several issues he has raised.

1) The biological world certainly contains classes of components that obey the laws of mechanics. A finite number of sardines or of college students can be packed into a can or a telephone booth, respectively; gravity keeps most of us in our place, and modifications of the kinetic theory of gases have been applied meaningfully



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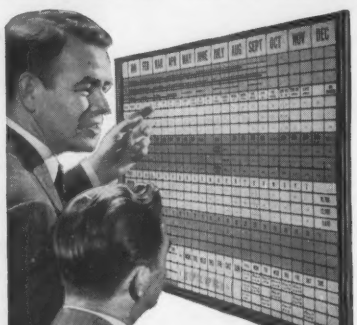

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to such component interactions as antigen-antibody agglutination, phage-bacterium adsorption, sperm-egg fertilization, and ciliate-ciliate mating.

2) With respect to similarities between organelles, there is no evidence that all cilia are derived from one common progenitor cilium. One of the important hypotheses expounded in my article is that of the *de novo* origin of such organelles by means of physically limited developmental processes from genetically limited sub-organellar-level macromolecular pools.

3) That the topological play is far-fetched is merely Nicholls' unsupported value judgment.

4) The reasons favoring the term *one-envelope system* over *free-living nucleus* are developed in the article. It is not clear to me from Nicholls' letter in what way he supposes them to be inconsistent with the recent work in bacterial biochemistry.

5) In addition to not citing some elegant works in biochemistry, I also elected to consider irrelevant to the crux of the argument much of the important contemporary work in sociology (people-people interrelations) and in nuclear physics (particle-strange particle interactions).

6) The concept of niche-filling is well understood in many professions. The tree cavity preempted by the starling will not be occupied at one and the same time by a flicker; an old French railway car will hold eight horses or 40 men; a simple keystone in an arch may be of marble or of brick or of wood, but not of all simultaneously. A more general concept of space-filling is appreciated by most physically minded people, including architects, city planners, and traffic managers. The important point is that, irrespective of the specific qualitative nature of the unit employed, fundamental geometrical and topological relationships are established between the units. It is at this level that we "intuitively" appreciate the shapes of things and many of the interrelationships in biology and society at large. In a rigorous analytical sense, we may evaluate a termite colony, a hardwood climax forest, an infantry regiment, or a political congress in session without once mentioning adenosine triphosphate or oxidative phosphorylation yet without underestimating their indispensability. In my article I have done this for the shapes of cells in terms of organelles. In other worlds, higher-level interrelationships might be formally similar to ours, but the molecular machinery might be quite different.

7) The possible role of organelles as receivers or transducers of electromagnetic energy was suggested from observations of their ultrastructure by

Fernández-Morán and seems inescapable from a knowledge of these objects. An important unanswered question is simply, "How much?"—a question provoked in the open mind by such knowledge.

8) The concept of organelle isotopy is structurally correct from both physical and etymological standpoints. Plant and animal, microorganismal and metazoan cilia have basically the same form. This similarity does not impose the limitation of common evolutionary origin on the structure itself in the developmental sense.

9) On or off the earth, "non-atoms" represent the subatomic particles. The term stems from the well-known philosophical device of *differentia and negative* and denotes a subset class that relates logically to the higher levels in the figure.

10) The lifetimes of such units as the enzyme-substrate complex are sufficiently short that ingenious instrumental measures, such as those conceived and brilliantly executed by Britton Chance, have been needed for their measurement. As pointed out in the article, the very organelles in or on which these fleeting events occur may be observed in vivo by cytologists at relative leisure. The qualification "relatively" was used by me deliberately and precisely to emphasize comparative lifetimes.

11) I cannot explain Nicholls' failure to find a need for a bridge or a link. A current key concern in physiological genetics and developmental embryology is the construction and testing of hypotheses that relate directly to the ascent from the macromolecular level that is experienced in the lifetime of every organism. If authoritarianism must be resorted to, it is well known that eminent experimentalists since Altmann and Hertwig have grappled with this problem along lines closely analogous to mine. That Nicholls' general accusation—that I have underestimated the contributions of biochemistry at the one extreme or of evolutionary theory at the other—is unfounded may be seen from a careful reading of my article and of the contextually relevant sections of the references cited.

CHARLES F. EHRET
Laboratoire de Biophysique, Université de Genève, Geneva, Switzerland

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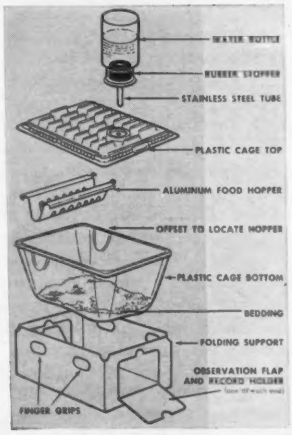

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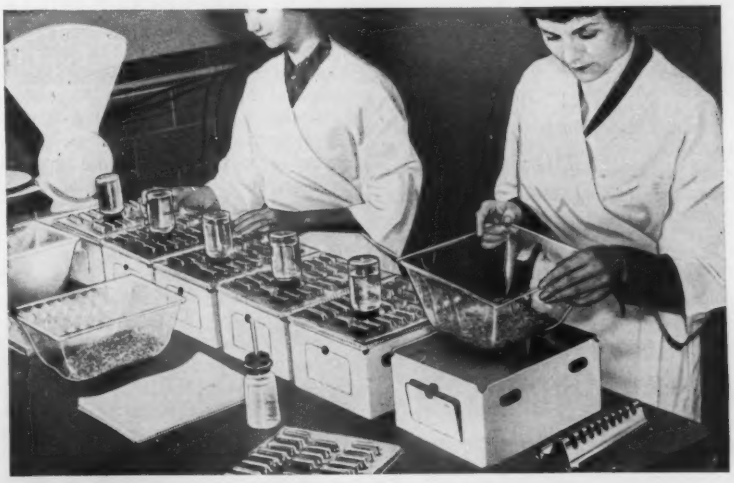

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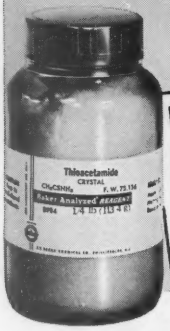

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the data, however, appears equally plausible. Dement's procedure, in brief, was as follows: to determine the subject's base-line total nightly dream time and sleep pattern, eye movements and brain waves were recorded during a variable number of undisturbed nights of sleep. During the subsequent nights the subjects were awakened each time the electromyographic (EMG) eye-leads indicated that they were dreaming (and the electroencephalographic [EEG] leads presumably indicated that they were in light sleep). Immediately after, when allowed a number of undisturbed nights of sleep ("recovery nights"), the EMG showed a significant elevation in the nightly dream time as compared with the base-line levels. This finding is open to the following interpretation: The psychological disturbance caused by the abrupt awakenings (as indicated by "anxiety, irritability . . . difficulty in concentrating . . . apparent panic") was closely correlated with a disturbance in the sleep pattern which included an increase in the amount of time spent in light sleep. Since evidence previously presented by Dement and Kleitman [*Electroencephalog. and Clin Neurophysiol.* **9**, 673 (1957)] strongly suggests that dreaming occurs during periods of light sleep, the "progressive increase in the number of attempts to dream" during the "dream deprivation" nights and the increased percentage of dream time during the "recovery nights" may have been a secondary consequence of the increase in light sleep time during these periods.

After a varying number of nights off, the same subjects returned to the experimental room and were awakened when the EMG indicated that they were *not* dreaming (and the EEG presumably indicated that they were in deep sleep). Subsequently, when permitted a number of undisturbed nights of sleep ("recovery nights"), the EMG did *not* show an increase in the amount of dream time over the base-line levels. This finding can be interpreted as follows: By this time the subjects had become adjusted to the procedure. Since they were now habituated and undisturbed, they slept normally; consequently, as compared with the base-line levels, they did not show a significant change in the percentage of light sleep time or the percentage of dream time during the "recovery nights" (or during the preceding nondream awakening nights).

It would be inappropriate to accept either Dement's interpretation or the above interpretation until a second experiment is completed in which subjects are *first* awakened when the EMG indicates that they are *not* dreaming and, after an intervening "recovery" period, are awakened when the EMG indicates that they are dreaming. Such an experiment may give the opposite results of those reported by Dement: Subjects may show an increased amount of dreaming during "recovery nights" which follow nondream awakenings and no significant increase in the amount of dreaming during "recovery nights" which follow "dream deprivation."

THEODORE XENOPHON BARBER
Worcester Foundation for Experimental Biology and *Medfield State Hospital, Harding, Massachusetts*

I wish to comment briefly on William Dement's tentative interpretations of the effects of his experimental studies in dream deprivation. Over two decades ago Nathaniel Kleitman put forth the notion of a subcortical wakefulness center which influenced the course of events in the sleep-wakefulness cycle. The more recent studies on the reticular activation system appear to have borne out some of these earlier ideas. When these data are considered in connection with the elucidation of the existence of the corticofugal fibers linking the cortex with the reticular system, and thereby creating a reverberating circuit, we have the beginnings of a neurophysiological model elucidating the dreaming process. We know as a result of the recent studies of Kleitman and his associates that repetitive bouts of partial arousal associated with dreaming occur universally as a nightly process. At certain times during the night it would appear as if the threshold in the reticular system is low enough for partial cortical arousal to occur. The events associated with this are experienced subjectively as the dream; but objectively these events further influence the threshold in this system. It is in this manner that it has been suggested that the cortex participates in its own arousal.

Freud had no neurophysiological model to serve as a guide in evolving his own dream theory. He was forced to see the dream as psychologically inspired by a disturbing unconscious impulse and as taking shape through the mechanism of dream work oriented towards disguising the impulse and maintaining sleep. The neurophysiological model, by comparison, suggests that the level of arousal varies during the night in a rhythmically patterned manner and that states of partial arousal are associated with more or less extended periods of dreaming.

Dement's study is concerned with the question of what happens when these events are interfered with in a specific way, namely, by eliminating that aspect of the cycle associated with dreaming. Both direct effects relating to dreaming and indirect, more distant effects relating to generalized behavioral disturbances were noted.

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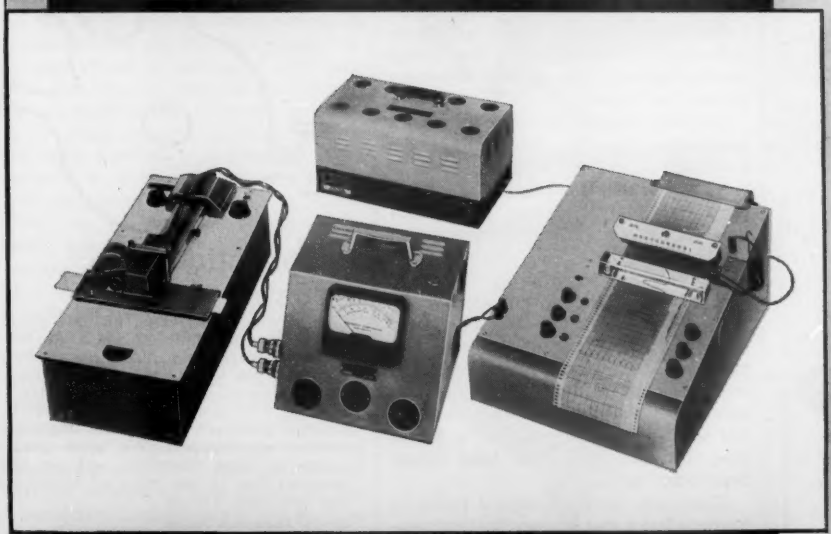

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sible directions in evaluating the direct results of dream deprivation experiments. One can minimize all factors other than the occurrence of dreaming and thus focus mainly on the subjective aspects of the experience. One then begins to talk as Dement does: "It is as though a pressure to dream builds up . . ." and ". . . a certain amount of dreaming each night is a necessity."

A second approach would emphasize the fact that the experimenter is interfering with states of partial arousal which presumably may have significance for the organism apart from dreaming. If these states of repetitive partial arousal are, for example, associated with vigilance operations during sleep, then the direct effects noted—namely, the increased frequency of dream attempts on the experimental nights and the increased nightly dream time on the recovery nights—may represent states of heightened vigilance of which dreaming is but one manifestation.

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Theodore Barber's alternative interpretation of the results is based mainly on his perception of a methodological weakness in the experimental procedure. He feels that the multiple awakenings, in and of themselves, could have been responsible for the rise in dream time seen on recovery nights after all, because, as he points out, the control awakening series always followed the dream deprivation series and "by this time the subjects had become adjusted to the procedure." He feels that if the control awakening series had been carried out *before* the dream deprivation awakening series, one might have seen a dream time rise following the control awakenings and little or none following dream deprivation.

Although we did not consider such a possibility "equally plausible" at the time the article was in preparation, it was obvious that it could not be entirely ruled out. Happily, there is no need now for an exhaustive documentation of the reasons for our original judgment. We have recently concluded experiments along the line independently suggested by Barber in his letter; and we have found that a second dream deprivation series in the same subject is as effective as the first, that no habituation is apparent, and that when the control series is carried out first, a dream time rise still follows the later dream deprivation series.

There are, however, several points in Barber's letter that warrant further comment. First, one of his contentions seems to be that abrupt awakenings caused the observed psychological disturbances. In all our work in this area,

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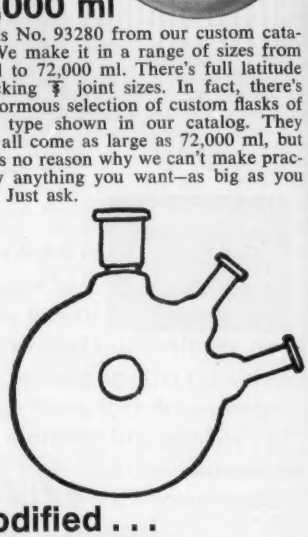

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one thing that has continued to impress us is how well subjects tolerate various disturbances of their sleep. When we were waking subjects many times a night to elicit dream recall in our early studies, we never observed any sort of psychological disturbance. To be sure, until the dream deprivation experiments were made, we had never done 20 to 30 awakenings in a single night. However, with the support of our more recent experiments, we are still inclined to view the psychological disturbances reported in the article as a *secondary* consequence of the reduction in dream time and not as a primary result of awakenings per se.

Second, taking his cue no doubt from my own statement in the article which referred to earlier work, "the eye movement periods were observed to occur regularly throughout the night in association with the lightest phases of a cyclic variation in depth of sleep as measured by the electroencephalogram," Barber uses the term, *light sleep*, saying, "the increased percentage of dream time during the recovery nights may have been a secondary consequence of the increase in light sleep time during these periods." It should be made very clear that what is meant by "light sleep" in this context can only be the so-called rapid eye movement period. The term, *eye movement period*, refers to a discrete interval of sleep during which rapid eye movements are seen in association with a characteristic low voltage, nonspindling EEG pattern (called stage 1 by us) which persists unchanged throughout the entire period although the amount of the eye movement may vary widely. Dreaming, as shown by earlier work, very likely occurs throughout the entire eye movement period, its presence being specifically indicated by the appearance of the stage 1 EEG pattern. The rapid eye movements are also related to dreaming, but more precisely to the visual imagery involved, and accordingly may vary in quantity from virtually none to many depending on what the dreamer is doing in the dream. Thus, for all practical purposes, the terms *eye movement period, stage 1 period, dream period*, and Barber's *light sleep* are synonymous. It should now be apparent that one cannot say, as Barber does, that increased dream time is a secondary consequence of an increase in light sleep time. The light sleep (stage 1 EEG) stage is simply the physiological concomitant of dreaming. Until more is known about mind-brain interaction, it might just as well be said that the increase in light sleep time was a secondary consequence of the increase in dream time.

Perhaps Barber had some other attributes in mind when speaking of light sleep which made his proposition seem

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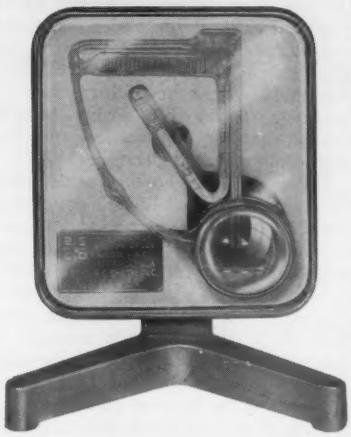

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more reasonable. However, these should be specified because light sleep (or deep sleep) is a concept that can have objective meaning only in terms of the variable or variables used to describe it. One may speak of light sleep in terms of a low voltage EEG (as we have), or a low arousal threshold, or a high incidence of body movement, or a high heart rate, and so forth. Unfortunately for the concept, the various measures of lightness of sleep do not correlate well with each other. For example, the incidence of gross body movement is lower during stage 1 (dream) sleep than during adjacent periods of stage 2 (deeper) sleep. I personally feel that if depth of sleep must be measured, the most meaningful criterion is the arousal threshold. Even in this instance dreaming fails to qualify as light sleep. Current work in several laboratories seems to indicate that subjects are often more difficult to arouse while dreaming than at certain other times. The use of the EEG, or any other variable, as *the* criterion of depth of sleep is merely a matter of taste or convenience, and probably depends to some extent on how well the chosen variable fits the experimenter's personal subjective notion of this elusive characteristic.

A final point is that the eye movement potentials are not muscle potentials and hence the eye movement record is not an EMG (electromyogram). There is a more or less steady potential difference existing across the eyeball (cornea positive–retina negative). The eye movement potential is a consequence of the spatial change of the electrical field of the eyeball dipoles with reference to the fixed periorbital electrodes. Passive movement of the eyes will elicit such a potential with reference to fixed recording points, and retinal destruction will abolish it. There is no evidence of EMG potentials in the recordings that we routinely obtain, presumably because the extraocular muscles are too far from the recording electrodes.

Some of the above considerations may also apply to Ullman's comments. He refers to the dream periods as states of "partial arousal" perhaps "associated with vigilance operations during sleep." It seems to me that the term, *partial arousal*, is as ambiguous as the term *light sleep*. If by "partial arousal" is meant only the occurrence of the stage 1 EEG pattern, then the term is redundant. If the state of partial arousal is thought to have some other attribute (for example, we might logically assume it would include a lowered arousal threshold), again, we must ask, is this additional attribute in fact associated with the stage 1 EEG period and dreaming?

The periodic occurrence of a low voltage, fast EEG stage during normal sleep has also been observed in cats by myself [*Electroencephalog. and Clin. Neurophysiol.* **10**, 291 (1958)] and Jouvet *et al.* [*Compt. rend. soc. biol.* **153**, 1024 (1959)]. Since we can do no more than speculate about dreaming in cats, and since it seems unlikely that cats dream in the manner of humans, we might assume that the occurrence of a low voltage, fast EEG stage in this animal is a pure example of a vigilance operation. It might follow that during these periods the cat is more alert to various stimuli, and that the frequent occurrence of such periods during sleep greatly enhance his chances for survival. However, even here, where the issue of dreaming does not complicate the picture, the cat is, if anything, less vigilant. Jouvet reports a definite *increase* in arousal threshold during these low voltage periods as opposed to the slow wave stage of sleep, and, in a less refined study, I found that it was difficult to differentiate the two phases in terms of arousal threshold. I think that Ullman must recast his definition of vigilance with an eye to some of the more recent findings regarding the functional significance of the various EEG patterns during sleep. I think that he might also ask himself how much of the current neurophysiology of the brain stem really applies to the physiology of sleep in a more than speculative way, especially since there are still large gaps in a purely descriptive picture of sleep physiology.

WILLIAM DEMENT
Department of Psychiatry,
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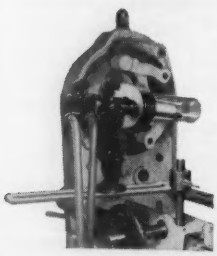

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This statement contains several errors. First, it may give people the incorrect impression that apochromats were produced empirically (by craftsmen), whereas it ought to be well known that they were designed entirely mathematically by the famous professor

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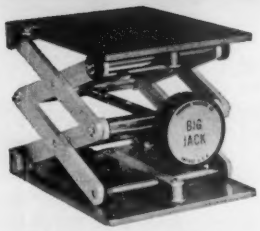

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Ernst Abbe after he had induced the firm of Schott, in Jena, to produce the new sorts of glass which he had asked for on theoretical grounds. The grinding and mounting of the lenses is indeed craftsmanship; the design of the apochromats is not craftsmanship but applied science. Further, Ashby confuses the principle of the immersion objective with that of apochromatic correction. These are, of course, entirely independent. The principle of oil immersion objectives dates back to Amici (1784–1863), although his *Papaver* oil immersion system was not a really homogeneous immersion like Abbe's (in fact most modern oil immersion objectives are not truly homogeneous immersions either).

Later on in the article it is suggested that the detection of chromosomes was made possible by the invention of the apochromats, whereas in reality this was due entirely to improvements in microscope technique. In properly prepared sections or squash preparations chromosomes can be detected easily with objectives of considerably older design than the first apochromats.

While agreeing completely as to the need for popularization of science in the way Ashby proposes, I think it should be emphasized that the facts presented must be true.

C. VAN DUIJN
Biophysics Department, Research Institute for Animal Husbandry "Schoonoord," Utrecht, Netherlands

I am familiar with the facts van Duijn mentions, but I do not follow his reasoning when he implies that because of these facts the statement of mine which he quotes "contains several errors." Without craftsmen there would have been no apochromatic lenses. It is a matter of judgment whether the improvement of microscopes in the 19th century owed more to craftsmen than to physicists. I think it did. Van Duijn thinks otherwise. But our differences are matters of the interpretation of history. They do not justify either of us in accusing the other of error.

Similarly with homogeneous immersion lenses: I believe that the fundamental advance was made by Abbe. And as for van Duijn's assertion that the observation of chromosomes was due "entirely" to improvements in techniques for staining and mounting cells, I readily agree that these techniques were of critical importance, but I wonder whether he has tried to draw the morphology of a dividing nucleus under a pre-apochromatic microscope. I have, and I stick to my statement.

ERIC ASHBY
Clare College, Cambridge, England

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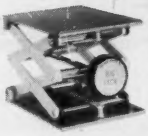

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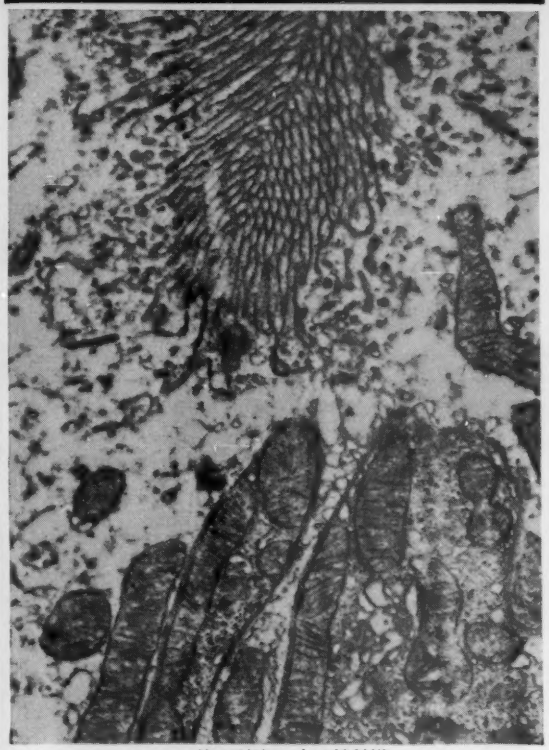

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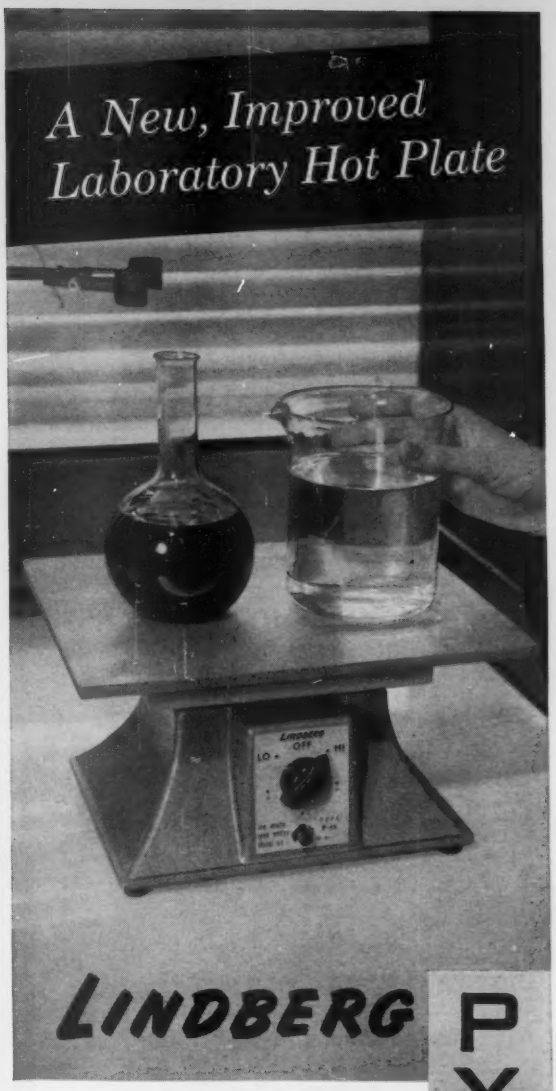

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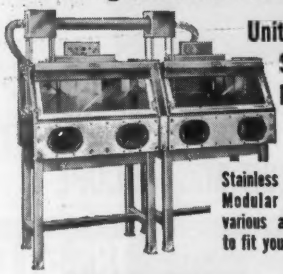

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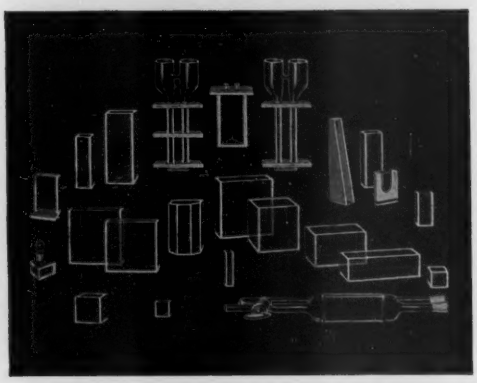

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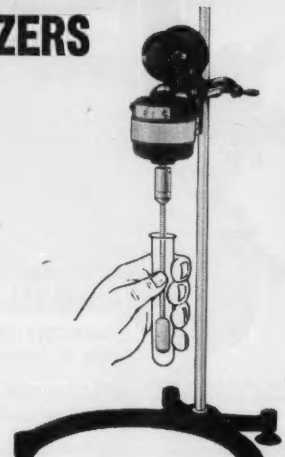

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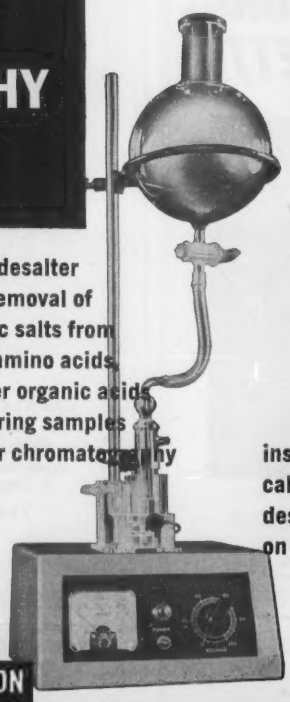

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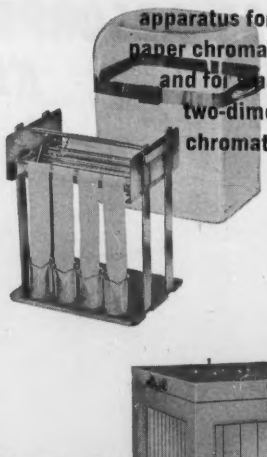

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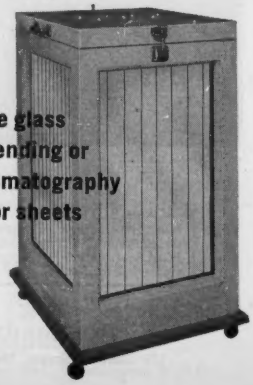

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Meetings

Friends of the Pleistocene

The 23rd field conference of the eastern division of the Friends of the Pleistocene was held in western New York on 20–22 May. Approximately 125 geomorphologists, glacial geologists, ground-water geologists, pedologists, and palynologists from Ontario, Quebec, the New England and Middle Atlantic states, Ohio, Indiana, Michigan, South Carolina, and Louisiana participated in this sixth reunion to be held in New York state. Leader of the conference was Ernest H. Muller of Syracuse University, whose investigations in Chautauqua, Cattaraugus, and adjacent counties have been sponsored by the New York State Museum and Science Service since 1956. Clair Brown of Louisiana State University, William S. Benninghoff of the University of Michigan, and Edward Ketchledge of the New York State College of Forestry at Syracuse University contributed paleobotanical data.

The group gathered at the Dunkirk Conference Grounds, Dunkirk, N.Y., on 20 May. The next day they traveled by automobile caravan southeast from Dunkirk through Gowanda and Otto to Olean. Leaving the Erie lake plain in the morning, the convoy traversed progressively older terrain from the Warren and Whittlesey strands, across late Cary moraines of the plateau margin, to early Wisconsin features of the Olean drift border. The second day's travel was westward from Olean to Salamanca along the drift border northeast of the Salamanca re-entrant.

Much of the first day was devoted to problems of glacial stratigraphy. Applicability of mechanical analysis as a criterion for till correlation was discussed at the first stop, on the outermost of the late Cary moraines southwest of Dayton. This moraine is composed of Hiram till and tentatively correlated with the Defiance moraine of Ohio and northwestern Pennsylvania. Eastward in New York the matrices of correlative upland and valley bottom till samples may differ more than the tills of contrasting moraines, and the criterion so far is not applicable. The question of how to distinguish between clay derived from comminution of shale and that from assimilation of lake sediments was discussed, without satisfactory conclusion.

At the Gowanda high bluff and Gowanda Hospital sites, four very similar tills are separated by lake silts. Discussion centered around criteria for evaluating the deglaciation represented by each set of nonglacial deposits of an oscillatory ice margin fronting on deep pro-glacial lake waters.

Deposits of post-Sangamon, pre-Farmdale age were studied at the Gowanda Hospital site and at the classic Otto site described previously by MacClintock and Apfel. At Gowanda a distinctive pink silt till, similar in color to till of the Ontario lake plain but unlike anything else in the immediate vicinity, underlies crumpled and deformed flood-plain deposits containing sparse invertebrate tests, *Picea* and *Pinus* pollen, and wood dated as older than 38,000 years (sample W-866, U.S. Geological Survey). At Otto, more abundant organic remains dated as older than 52,000 years (sample Gro 2565, Groningen Laboratory) represent the southern aspect of the boreal forest and are suggestive of climatic conditions slightly more rigorous than present conditions rather than of the mild conditions of the Sangamon to which they had previously been assigned.

Considerable attention was devoted also to periglacial and drift border conditions. At The Narrows, the postulated divergence of the Binghamton and Olean drift borders was considered. Discussion arose as to whether stone nets near the Wisconsin glacial border and the Olean Rock City in the unglaci-

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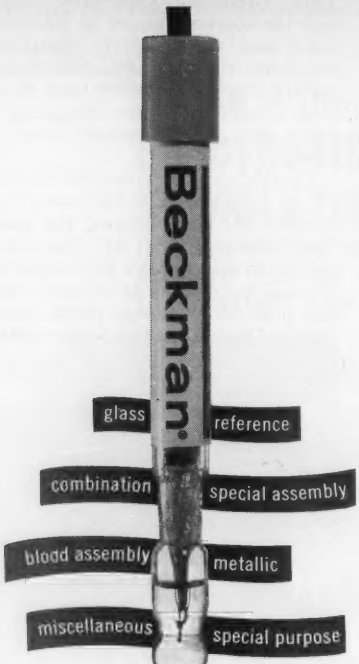

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ated Salamanca re-entrant represent periglacial conditions or are in process of active development under the present environment. The upland peneplain was introduced as evidence of the relative ineffectiveness of glacial scour on summits near the limits of glaciation.

ERNEST H. MULLER
Department of Geology, Syracuse University, Syracuse, New York

Forthcoming Events

November

29–30. Air Research and Development Command, Science and Engineering Symp., 7th annual, Boston, Mass. (Office of information, Headquarters, ARDC (Attention: RDEP), Andrews AFB, Washington 25)

30–2. Steels in Reactor Pressure Circuits, symp., London, England. (Secretary, Iron and Steel Inst., 4 Grosvenor Gardens, London, S.W.1)

December

1–16. Commission for Climatology, 3rd session, London, England. (World Meteorological Organization, Campagne Rigot, 1, avenue de la Paix, Geneva, Switzerland)

2–5. Central American Medical Conf., 8th, Panama City. (A. Bissot, Departamento de Saud Publica, Ministerio de Trabajo, Prevision Social y Salud Publica, Panama)

3–6. Visual Communications, 4th annual intern. cong., Chicago, Ill. (Visual Communications Cong., 10600 Puritan Ave., Detroit 38, Mich.)

3–8. American Acad. of Dermatology and Syphilology, Chicago, Ill. (R. R. Kierland, First National Bank Building, Rochester, Minn.)

4–6. Spectroscopy, annual southern seminar, Gainesville, Va. (Annual Seminar on Spectroscopy, Univ. of Florida, Gainesville)

4–7. American Inst. of Chemical Engineers, annual, Washington, D.C. (F. J. Van Antwerpen, AICE, 25 W. 45 St., New York 36)

4–9. Radiological Soc. of North America, Cincinnati, Ohio. (D. S. Childs, 713 E. Genesee St., Syracuse 2, N.Y.)

5–7. American Soc. of Agricultural Engineers, winter, Memphis, Tenn. (J. L. Butt, 420 Main St., St. Joseph, Mich.)

5–7. Electronic Industries Assoc., 3rd conf. on maintainability of electronic equipment, San Antonio, Tex. (E. B. Harwood, Office of the Secretary of Defense, Room 3D1018, Pentagon, Washington 25)

5–8. American Rocket Soc., 15th annual, Washington, D.C. (R. L. Hohl, ARS, 500 Fifth Ave., New York 36)

5–8. American Soc. of Agronomy, annual, Chicago, Ill. (L. G. Monthey, ASA, 2702 Monroe St., Madison 5, Wis.)

7–13. American Acad. of Optometry, San Francisco, Calif. (C. C. Koch, 1506–08 Foshay Tower, Minneapolis 2, Minn.)

9–10. The Myocardium—Its Biochemistry and Biophysics, New York, N.Y. (A. P. Fishman, New York Heart Assoc., 10 Columbus Circle, New York 19)

9–11. American Psychoanalytic Assoc., New York, N.Y. (D. Beres, 151 Central Park West, New York 23)

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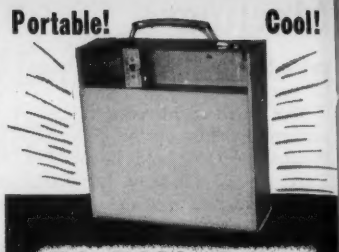

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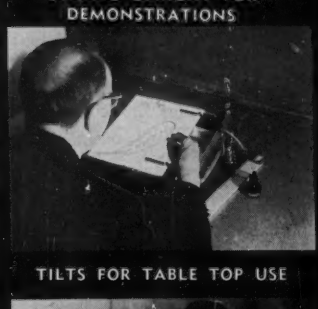

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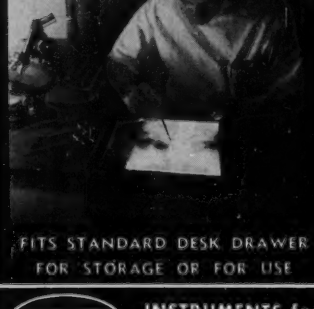

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10–11. Academy of Psychoanalysis, New York, N.Y. (J. H. Merin, 125 E. 65 St., New York 21)

11–14. Hot Laboratory and Equipment Conf., 8th, San Francisco, Calif. (J. R. Lilienthal, Los Alamos Scientific Laboratory, P.O. Box 1663, Los Alamos, N.M.)

12–14. American Nuclear Soc. (Isotopes and Radiation Div.), San Francisco, Calif. (O. J. Du Temple, ANS, 86 E. Randolph St., Chicago 1, Ill.)

12–14. Water Pollution, natl. conf., Washington, D.C. (F. A. Butrico, Office of Engineering Resources, Div. of Engineering Services, U.S. Public Health Service, Washington 25)

12–16. Atomic Industrial Forum, conf., San Francisco, Calif. (D. J. Scherer, 3 E. 54 St., New York 22)

13–15. Eastern Joint Computer Conf., New York, N.Y. (E. C. Kubie, EJCC, Computer Usage Co., Inc., 18 E. 41 St., New York 17)

19–20. Statistical Mechanics, conf., London, England. (Organizing Secretary, Physical Soc., 1, Lowther Gardens, London)

22–2. Panamerican Diabetic Congress, 1st, British Honduras. (B. R. Hearst, Director, Diabetic Inst. of America, 55 E. Washington St., Suite 1646, Chicago 2, Ill.)

26–30. Inter-American Cong. of Psychology, 7th, Havana, Cuba. (G. M. Gilbert, Psychology Dept., Long Island Univ., Brooklyn 1, N.Y.)

26–31. American Assoc. for the Advancement of Science, annual, New York, N.Y. (R. L. Taylor, AAAS, 1515 Massachusetts Ave., NW, Washington 5)

The following 52 meetings are being held in conjunction with the AAAS annual meeting.

AAAS Committee on Science and the Promotion of Human Welfare (B. Commoner, Shaw School of Botany, Washington Univ., St. Louis 5, Mo.). 26, 28, 29 Dec.

AAAS Cooperative Committee on the Teaching of Science and Mathematics (J. R. Mayor, Director of Education, AAAS, Washington, D.C.). 28, 29 Dec.

Academy Conference (J. G. Arnold, Jr., Loyola Univ., New Orleans, La.). 26–27 Dec.

Alpha Epsilon Delta (M. L. Moore, 7 Brookside Circle, Bronxville, N.Y.). 29 Dec.

American Assoc. of Clinical Chemists (H. Goldenberg, Dept. of Biochemistry, Hillside Hospital, P.O. Box 38, Glen Oaks, N.Y.). 26–27 Dec.

American Assoc. of Scientific Workers (Miss M. Yevick, 214 Western Way, Princeton, N.J.). 27 Dec.

American Astronautical Soc. (R. Fleisig, 58 Kilburn Rd., Garden City, N.Y.). 27 Dec.

American Astronomical Soc. (J. A. Hynek, Dearborn Observatory, Northwestern Univ., Evanston, Ill.). 28–31 Dec.

American Council on Women in Science (Miss E. B. Thurmann, Div. of Research Grants, National Insts. of Health, Bethesda 14, Md.). 27 Dec.

American Economic Assoc. (K. E. Boulding, Dept. of Economics, Univ. of Michigan, Ann Arbor). 26 Dec.

American Geophysical Union (R. Jastrow, NASA Theoretical Div., 8719 Colesville Rd., Silver Spring, Md.). 26 Dec.

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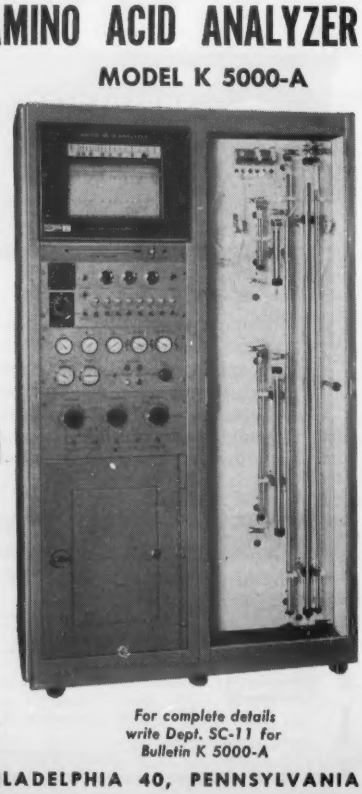

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American Nature Study Soc. (R. E. Hopson, 4138 S.W. Fourth Ave., Portland 1, Ore.). 27–30 Dec.

American Psychiatric Assoc. (P. H. Knapp, Boston Univ. School of Medicine, Boston, Mass.). 29, 30 Dec.

American Soc. of Criminology (D. E. J. MacNamara, New York Inst. of Criminology, 115–117 W. 42 St., New York 36). 26, 27 Dec.

American Soc. of Naturalists (R. C. Rollins, Gray Herbarium, Harvard Univ., 22 Divinity Ave., Cambridge 38, Mass.). 27 Dec.

American Soc. of Zoologists (R. L. Waterson, Dept. of Zoology, Northwestern Univ., Evanston, Ill.). 28–30 Dec.

American Sociological Assoc. (V. H. Whitney, Dept. of Sociology, Wharton School of Finance, Univ. of Pennsylvania, Philadelphia, Pa.). 28, 29 Dec.

American Statistical Assoc. (R. E. Lewis, New York Area Chapter, 55 Wall St., New York 15). 29 Dec.

Association of American Geographers (C. Morrison, Jr., American Geographical Soc., Broadway at 156 St., New York 32). 27–30 Dec.

Association for Computing Machinery (W. F. Cahill, NASA, 8719 Colesville Rd., Silver Spring, Md.). 29 Dec.

Astronomical League (Miss A. A. Pindar, Amateur Astronomers Assoc., Inc., 223 W. 79 St., New York 24). 28 Dec.

Beta Beta Beta Biological Soc. (Mrs. F. G. Brooks, P.O. Box 515, Ansonia Station, New York 23). 27 Dec.

Biomedical Information Processing Organization (R. S. Ledley, Natl. Biomedical Research Foundation, Silver Spring, Md.). 30 Dec.

Committee on Cosmetics, American Medical Assoc. (J. B. Jerome, 535 N. Dearborn St., Chicago 10, Ill.). 29 Dec.

Conference on Scientific Communication Problems (G. L. Seielstad, Technical Reports Group, Applied Physics Laboratory, Johns Hopkins Univ., Silver Spring, Md.). 26, 27 Dec.

Conference on Scientific Manpower (T. J. Mills, Natl. Science Foundation, 1951 Constitution Ave., NW, Washington 25). 27 Dec.

Conference on Scientific Manuscripts (N. Reingold, Dept. of History of Science and Medicine, Yale Univ., New Haven, Conn.). 29 Dec.

Ecological Soc. of America (R. S. Miller, Dept. of Biology, Univ. of Saskatchewan, Saskatoon, Saskatchewan, Canada). 26–31 Dec.

History of Science Soc. (D. J. de Solla Price, Dept. of History of Science and Medicine, Yale Univ., New Haven, Conn.). 27–29 Dec.

Institute of Management Sciences (M. M. Flood, Mental Health Research Inst., 205 N. Forest Ave., Ann Arbor, Mich.). 30 Dec.

Metric Assoc. (J. T. Johnson, 694 W. 11 St., Claremont, Calif.). 27 Dec.

Mountain Lake Biological Station (H. H. Hobbs, Jr., Univ. of Virginia, Charlottesville, Va.). 29 Dec.

National Acad. of Economics and Political Science (A. E. Taylor, Parkton, Md.). 27 Dec.

National Assoc. of Biology Teachers (P. Webster, Bryan City Schools, Bryan, Ohio). 27–30 Dec.

National Assoc. for Research in Science

Teaching (G. Mallinson, School of Graduate Studies, Western Michigan Univ., Kalamazoo). 27 Dec.

National Assoc. of Science Writers (E. Ubell, Herald Tribune, New York, N.Y.). 27 Dec.

National Geographic Soc. (W. R. Gray, NGS, 16th and M Sts., NW, Washington 6). 30 Dec.

National Speleological Soc. (Brother Nicholas, FSC, Dept. of Biology, Univ. of Notre Dame, Notre Dame, Ind.). 27 Dec.

Nature Conservancy (J. W. Brainerd, Springfield College, Springfield, Mass.). 27 Dec.

New York Acad. of Sciences (D. Purpura, College of Physicians and Surgeons, Columbia Univ., New York, N.Y.). 30 Dec.

Science Clubs of America (Miss L. V. Watkins, Science Service, 1719 N Street, NW, Washington 6). 30 Dec.

Scientific Research Soc. of America (D. B. Prentice, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Sigma Delta Epsilon (Mrs. E. Cortelyou, Aeroprojects Inc., W. Chester, Pa.). 27–29 Dec.

Society for General Systems Research (C. A. McClelland, Dept. of History, San Francisco State College, 1600 Holloway Ave., San Francisco, Calif.). 29 Dec.

Society for the History of Technology (C. W. Condit, Dept. of English, Northwestern Univ., Evanston, Ill.). 27–29 Dec.

Society for Industrial and Applied Mathematics (J. Griesmer, IBM Research Center, Box 218, Yorktown Heights, N.Y.). 28 Dec.

Society for Industrial Microbiology (J. A. Ramp, 11 Van Dyke Rd., Waldwick, N.J.).

Society of the Sigma Xi (T. T. Holme, 56 Hillhouse Ave., New Haven 11, Conn.). 29 Dec.

Society for the Study of Evolution (H. H. Ross, State Natural History Survey, Urbana, Ill.). 27–29 Dec.

Society of Systematic Zoology (C. F. Lytle, Dept. of Zoology, Tulane Univ., New Orleans 18, La.). 27–29 Dec.

Tau Beta Pi Assoc. (R. H. Nagel, Tau Beta Pi Assoc., Univ. of Tennessee, Knoxville). 29 Dec.

Torrey Botanical Club (Miss A. Hervey, New York Botanical Garden, Bronx Park 56, N.Y.). 27 Dec.

27–14. Bahamas Surgical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

27–29. Conference on Strong Interactions, Berkeley, Calif. (A. C. Helmholz, Dept. of Physics, Univ. of California, Berkeley.)

27–29. Northwest Scientific Assoc. and Idaho Acad. of Science, joint meeting, Moscow. (E. J. Larrison, Dept. of Biological Sciences, Univ. of Idaho, Moscow.)

28. Association for Education in International Business, St. Louis, Mo. (J. N. Behrman, Univ. of Delaware, Newark, Delaware)

28–30. American Economic Assoc., St. Louis, Mo. (J. W. Bell, Northwestern Univ., Evanston, Ill.)

28–30. Econometric Soc., St. Louis, Mo. (R. Ruggles, Dept. of Economics, Yale Univ., New Haven, Conn.)

(See issue of 21 October for comprehensive list)

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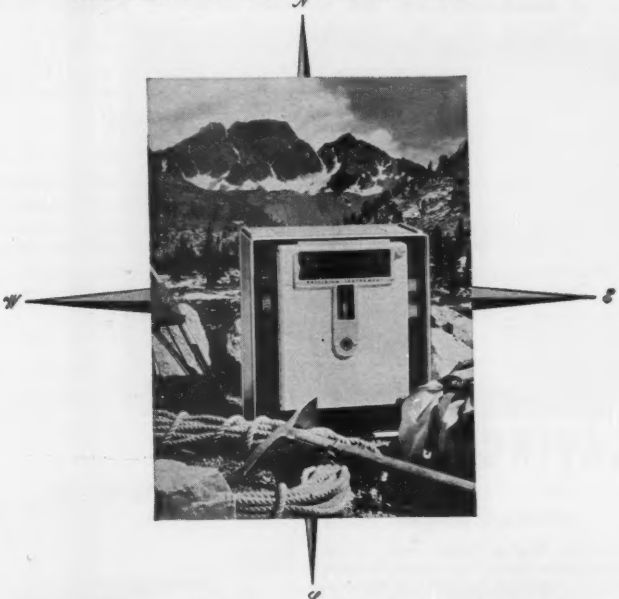

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■ SHAFT ANGLE ENCODER will store 10 bits of encoder data in a transistorized storage circuit on the fly at angular velocities up to 2 rev/sec and provide output in binary code and the complement. Accuracy is said to be ±1 part in 1000. The encoder will operate under 100 grav steady-state acceleration and 8 grav vibration up to 1000 cy/sec. (Datex Corp., Dept. Sci860, 1307 S. Myrtle Ave., Monrovia, Calif.)

■ PLASTIC COATING may be stripped from metal, leaving no film residue. The material, cellulose acetate butyrate, is supplied as solid plastic blocks melting at 360°F. Objects are coated by dipping in the molten plastic. The coating is removed by slitting and peeling. It is suggested by the supplier as a protective coating or as a mask during electroplating or painting operations. (Fidelity Chemical Products Corp., Dept. Sci876, 470 Freylinghuysen Ave., Newark 12, N.J.)

■ CORE BUFFER MEMORIES are designed to synchronize two data systems operating at different speeds. Capacity is 144 characters of 4 or 8 bits per character. Load or unload is performed at a 100-kcy/sec rate. All bits of each character are loaded and unloaded in parallel; characters are loaded and unloaded in sequence. In the type BA units, data are transferred in blocks of up to 144 characters; in the type BQ, characters may be loaded and unloaded in any manner desired. (Telemeter Magnetics Inc., Dept. Sci885, P.O. Box 329, Culver City, Calif.)

■ FOUR-WAY TOGGLE SWITCH has 8-pole double-throw contacts. From the center position it is possible to actuate double-pole double-throw circuitry in each of four momentary positions spaced 90 deg apart. Operating force is 0.5 lb. Rating is 5 amp resistive, 3 amp inductive, at 30 volts d-c and 115 volts a-c. (Haydon Switch, Inc., Dept. Sci878, Waterbury 20, Conn.)

■ NAVIGATION-AID TEST SET, for testing and calibrating air-traffic-control transponders and airborne distance-measuring navigation systems, contains a crystal-controlled radio frequency signal generator, a peak-pulse-power comparator, and a wavemeter. Crystal-controlled outputs are spaced 1 Mcy/sec in the ranges 960 to 1049 and 1130 to 1219 Mcy/sec. The power comparator indicates from 23 to 33 dbm ± 1db. The wavemeter covers the range 1070 to 1110 Mcy/sec and is said to be accurate to ±0.5 Mcy/sec. (Boonton Radio Corp., Dept. Sci871, Boonton, N.J.)

■ DELAY LINE provides three variable taps over a total delay of 1.5 μsec. The taps can be individually adjusted over the delay range with resolution of 0.025 μsec. Pulse rise time and attenuation for full delay are 0.27 μsec and 2 db maximum, respectively. Impedance is 300 ohms. (ESC Corp., Dept. Sci873, 534 Bergen Blvd., Palisades Park, N.J.)

■ DIFFERENTIAL VOLTMETER consists of a stable 500-volt d-c reference supply, a voltage dividing network and five-dial Kelvin-Varley divider, a calibrated multi-range vacuum-tube voltmeter, and an a-c to d-c converter. The vacuum-tube voltmeter may be used either in the conventional manner or as a null detector for comparing an unknown voltage with the internally selected reference voltage. Accuracy of d-c voltage measurement is said to be ±0.05 percent from 0.1 to 500 volts and ±0.1 percent or ±50 μv from 0 to 0.1 volt. Accuracies for a-c are given as ±0.2 percent from 0.5 to 500 volts with reduced accuracy from 0.05 to 0.5 volt. (John Fluke Mfg. Co., Dept. Sci877, P.O. Box 7161, Seattle 33, Wash.)

■ COMMAND RECEIVER is a completely transistorized, crystal-controlled, fixed-tuned receiver for operation over the 5 to 16 Mcy/sec range. An integral multi-tone decoder provides high immunity from interference. (LEL Inc., Dept. Sci872, 380 Oak St., Copiague, N.Y.)

■ MONITOR-ALARM SYSTEM is designed to verify the condition of 30 stations with accuracy of 1 part in 10^8. Inputs are signals from transducers. Permissible values for each station are punched into a standard punched card inserted into the monitor. All 30 channels are examined in less than 0.3 sec. Audible, visible, and electrical-signal outputs are provided. The circuitry is entirely solid state. (Franklin Electronics Inc., Dept. Sci880, 5901 Noble Ave., Van Nuys, Calif.)

■ ROTARY SEAL GLAND for glass-rod stirrers is available in four sizes: standard taper 24/40 and 29/42 supplied for 6-mm shaft, and 34/45 and 45/50 in either 6- or 10-mm size. The seal is constructed of Teflon with inner and outer O-ring seals of Viton A. The seal is said to be vacuum tight to 8 mm-Hg, to operate at temperatures as high as

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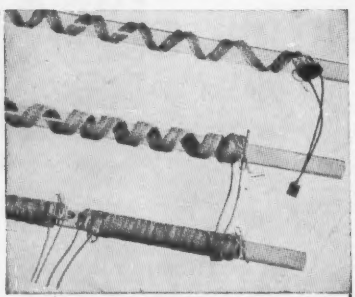

Electrothermal Heating Tapes consist of one or more fabric bands of resistance wire, separated or bordered by bands of high-temperature-resisting glass fibre yarn. The width and length of the various tapes are carefully determined by the current-carrying capacity of the resistance wire. Temperature of 400° C and over can be reached inside a glass tube of 2 mm wall thickness.

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3	1	100	1.6	$ 9.75 ea.	$11.40 ea.	$11.90 ea.
4	2½	250	3.0	12.25 "	15.00 "	18.75 "
5	3	450	4.6	16.75 "	20.25 "	26.50 "
6	3½	600	5.2	19.25 "	23.00 "	29.50 "
2	½	36	0.5			4.25 "
4	½	72	1.0			6.70 "
6	½	108	1.5			9.00 "
8	½	144	2.0			13.90 "
2	1	72	1.0			6.90 "
4	1	144	2.0			12.50 "
6	1	216	2.5			14.40 "
8	1	288	3.0			17.25 "
2	2	120	1.5			9.70 "
4	2	240	3.0			15.00 "
6	2	360	4.0			20.00 "
8	2	480	5.0			30.00 "
2	3½	210	2.5			13.90 "
4	3½	420	4.2			21.00 "
6	3½	630	7.5			29.50 "
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(Average load of Heating Tapes is 2½ Watts/Sq. In.)

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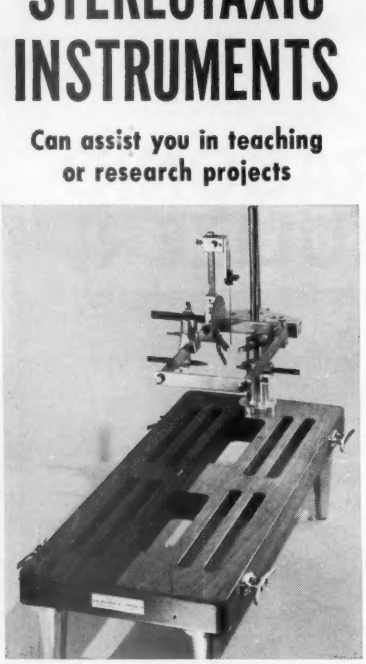

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200°C, and to be suitable for use with any materials except metallic sodium. (Arthur F. Smith, Inc., Dept. Sci881, 311 Alexander St., Rochester 4, N.Y.)

■ HARDNESS TESTER is a portable instrument that consists of a clamping device and an indenter head. Model M-I gives readings in the Rockwell-C scale with distance between anvil and penetrator 0 to 6.3 in. and 3.3 in. depth of throat. Model M-II provides 0 to 9.8 in. distance between anvil and penetrator and 5.1 in. depth of throat. Test loads are produced by springs. (American Chain and Cable Co., Dept. Sci874, Bridgeport, Conn.)

■ ULTRASONIC GENERATOR is rated at an output of 1000 watts average power and 2000 watts peak power at 38 to 42 kcy/sec. The generator will drive 192 $in.^2$ of barium-titanate crystal radiating surface. Operation is on 115-volt, 20-amp power. Weight is 225 lb. (National Ultrasonic Corp., Dept. Sci879, 111 Montgomery Ave., Irvington 11, N.J.)

■ ARC PROJECTOR collects radiation from a blown-type arc by means of first surface reflectors and concentrates it at the reimaging point. A circular radiation pattern totals 374 watts with 80 percent uniformity of field or 668 watts with 60 percent uniformity. A continuous spectrum is provided from 0.25 to 5.1 μ, with spectral energy distribution said to be very close to the solar energy distribution above the earth's atmosphere. (Strong Electric Corp., Dept. Sci897, 396 City Park Ave., Toledo, Ohio)

■ BLOOD PRESSURE RECORDER to accompany the manufacturer's continuous systolic monitor provides a linear trace of blood pressure from 0 to 300 mm-Hg on paper 4 in. wide. (Biophysical Electronics Inc., Dept. Sci884, New Hope, Pa.)

■ ACCELEROMETER, model 408, is designed especially for measurement of small accelerations. Sensitivity is 100 mv/grav. Maximum acceleration is 10,000 grav. Frequency range is 1 cy/ to 3 kcy/sec with resonance frequency at 55 kcy/sec and amplitude linearity ±1 percent. The transducer can be operated in noise fields as high as 160 db. Dimensions are ¾ in. hexagonal by 0.45 in. high. Weight is 23.5 g. (Columbia Research Laboratories, Dept. Sci898, Woodlyne, Pa.)

■ COINCIDENCE-ANTICOINCIDENCE ANALYZER is a four-channel instrument designed for use with Geiger and scintillation detectors. Any number or combination of the four channels may be used in coincidence, and one of the channels may be used in anticoincidence

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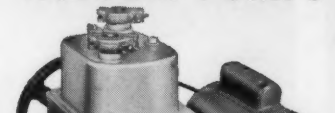

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with any one or combination of the other three channels. Channel dead time is less than 10 μsec. Input pulses may range from -50 to $+100$ volts. Output is -15 volts. (Radiation Instrument Development Laboratory, Inc., Dept. Sci893, 61 E. North Ave., Northlake, Ill.)

■ CATHODE-RAY OSCILLOSCOPE features a passband from d-c to 1000 Mcy/sec, rise time of 0.35 nsec, linear sweeps to 2 nsec/cm), and sweep delay to 30 nsec. The unit includes a fixed signal delay line, a sweep-delay control, a pulse-rate generator, a standard amplitude and waveform generator, and regulated power supplies. Viewing area is 2 by 6 cm. Spot size is 0.004 in. at 15 μa. A distributed-deflection cathode-ray tube with 24 kv accelerating potential is used. (Tektronix, Inc., Dept. Sci896, P.O. Box 500, Beaverton, Ore.)

■ ANGULAR MOTION TRANSDUCER converts motion to voltage over an angular range ± 40 deg with linearity said to be better than 0.025 percent. The force required to move the armature of the transducer is almost entirely the friction of its bearings, the reactive force being approximately 9 mg cm/deg. Scale factor is 0.57 volt (r.m.s.)/deg, and null voltage is less than 0.1 v. Operation is on 60 cy/sec excitation. (Brush Instruments, Dept. Sci899, 37 St. and Perkins, Cleveland 14, Ohio)

■ RESPIRATION MEASURING INSTRUMENT furnishes electrical outputs expressing both volume and flow. Maximum volume is 10 lit., and volume discrimination is ± 2 ml. Volume output is approximately 0.8 volt/lit., and flow output is approximately 0.1 volt/(lit. sec). Breathing resistance is said to be less than 1 mm-H_2O. Pushbutton calibration is provided. (Custom Engineering and Development Co., Dept. Sci888, 2647 Locust St., St. Louis 3, Mo.)

■ MULTIPLIER PHOTOTUBE, type 7664, is a 2-in. diameter, 10-stage tube, sensitive in the ultraviolet and visible light regions. It employs a focusing electrode for adjusting to optimum photoelectron efficiency. Minimum luminous sensitivity is 50 μa for white light types. Average sensitivity is 60 μa. The envelope is made of fused silica to permit transmission of ultraviolet radiation down to 1800 A. (Allen B. Du Mont Laboratories, Dept. Sci875, Clifton, N.J.)

■ INDICATOR, for displacement measurement with linear differential transformers, is a null-balance-servo type with scale length of 50 in. Ranges are 0 to 0.01 in. and 0 to 0.1 in. Resolution is said to be 1 part in 9000. Linearity is

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±0.1 percent of range for the indicator alone and stability is ±0.1 percent of range. Response time from zero to full scale is 4.5 sec. (Shaevitz Engineering Co., Dept. Sci901, U.S. Route 130 and Schaevitz Blvd., Pennsauken, N.J.)

■ PULSE GENERATOR furnishes a pulse of 100 mμsec duration and 20 mμsec rise and fall times. Pulse output is 0 to 10 kv into open circuit and 0 to 5 kv into a 50-ohm load. Peak power output is 0.5 Mw. Pulse repetition frequency is 60 cy/sec, internally synchonized, or 0 to 60 cy/sec, externally driven. Output pulse delay is 300 mμsec for 150 volts synchronized input and 140 mμsec for 400 volts input. (Electro-Optical Instruments Inc., Dept Sci883, 2612 E. Foothill Blvd., Pasadena, Calif.)

■ SHIELD ENCLOSURE for measuring electrical characteristics of materials and small components is equipped with an adapter that fits the input of the manufacturer's electrometers. The enclosure adds only a sapphire insulator of the terminal in parallel with the sapphire insulator of the electrometer probe. (Applied Physics Corp., Dept. Sci895, 2724 S. Peck Rd., Monrovia, Calif.)

■ MINIATURE SYRINGE has a total capacity of 1 μl subdivided into 100 parts. The plunger is a 0.006-in. tungsten wire that bottoms at the point of the 7-cm needle thus avoiding dead volume. Accuracy is said to be ±3 percent. (Hamilton Company, Dept. Sci889, P.O. Box 307, Whittier 40, Calif.)

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■ COMMUNICATION-WIRE CONNECTOR splices, insulates, and moisture seals two or three No. 19 to 26 AWG solid or 20 to 26 AWG stranded wires. Wires are inserted into the connector and secured by squeezing a button into the connector sleeve. This operation causes finger-like connector elements to strip insulation and grip the conductors. Factory installed silicone grease seals the joint against moisture. Pullout resistance is said to be 95 percent of wire breaking strength. (Minnesota Mining & Manufacturing Co., Dept. Sci902, 900 Bush Ave., St. Paul 6, Minn.)

■ CENTRIFUGE, a bench model, accommodates five interchangeable rotors for batch or continuous-flow separations. All the rotors may be spun at speeds up to 17,000 rev/min and centrifugal fields as great as 35,000 grav. Two of the rotors are 34-deg angle types with capacities 8 × 50 ml and 24 × 15 ml. Another is a zonal separation rotor with 80-deg angle and capacity 16 × 7 ml. Two other continuous-flow rotors have bowl capacities of 300 and 800 ml. (Lourdes Instrument Corp., Dept. Sci-905, 53rd St. & First Ave., Brooklyn 32, N.Y.)

■ PERFORATED-TAPE READER operates either single character or continuous run from an external trigger source. It will accommodate 5-, 6-, 7-, or 8-hole, 1-in. paper Mylar tape and operates at the rate of 60 characters per second, self-stepping, or 50 per second, impulse stepping. (California Technical Industries, Dept. Sci882, 1421 Old County Rd., Belmont, Calif.)

■ AUTOMATIC PIPETTE operates by piston displacement of fluid fed into an enclosed cylinder. Each turn of a 360-deg rotatable stopcock dispenses a fixed volume of liquid. Pipettes are available in sizes from 1 to 50 ml at any desired fractional increment. Accuracy is said to be ±0.002 ml for pipettes smaller than 10 ml and ±0.005 ml for larger sizes. Filling and emptying occur simultaneously. (Schueler & Co., Dept. Sci-904, 75 Cliff St., New York 38, N.Y.)

■ SYNTHETIC POLYPEPTIDES of high molecular weight available from stock include polymers of the following L-α-amino acids: glutamic acid, γ-benzyl glutamate, lysine hydrobromide ε-carbobenzoxylysine, O-carbobenzoxytyrosine, leucine, alanine, phenylalanine, and tyrosine. Also available on order are copolymers, special molecular weights, and polymers of amino acids having unnatural configurations. (Pilot Chemicals, Inc., Dept. Sci907, 36 Pleasant St., Watertown 72, Mass.)

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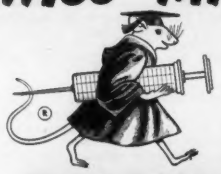

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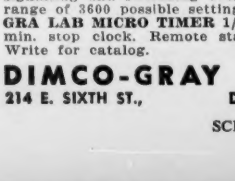

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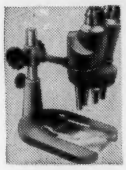

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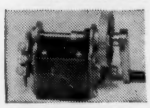

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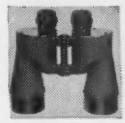

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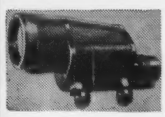

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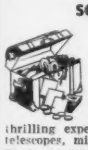

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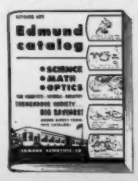

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